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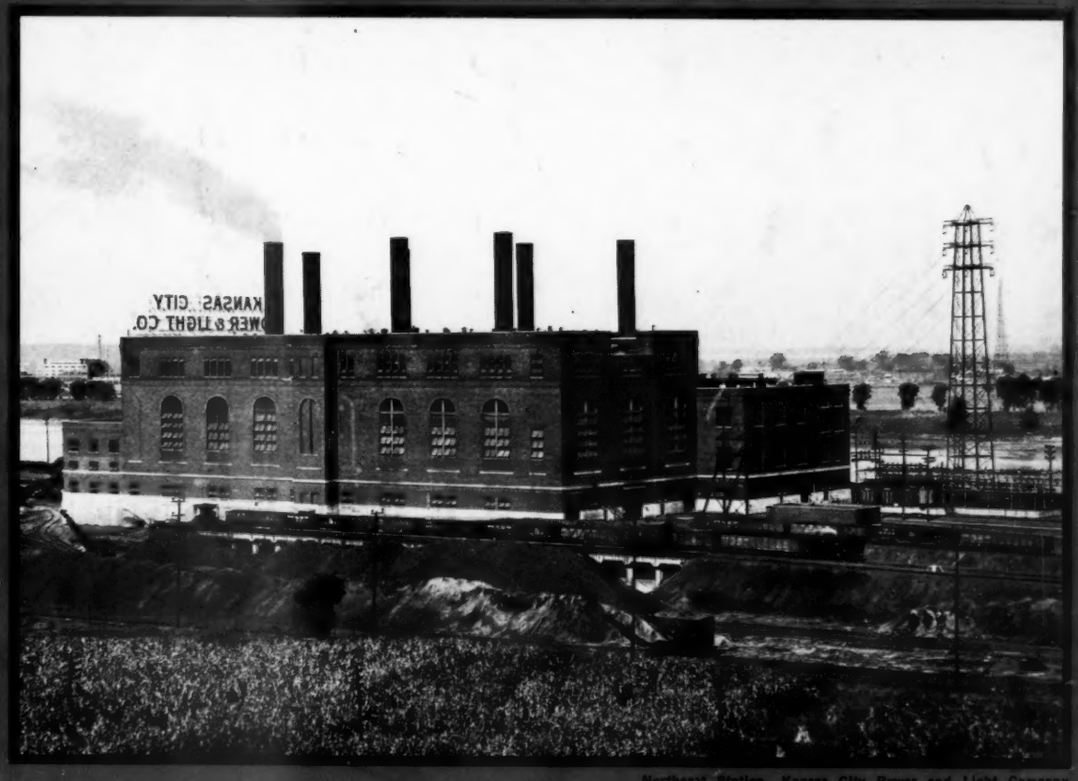


Northeast Station, Kansas City Power and Light Company

BURNING PULVERIZED PETROLEUM COKE BREEZE

By E. J. McDonald

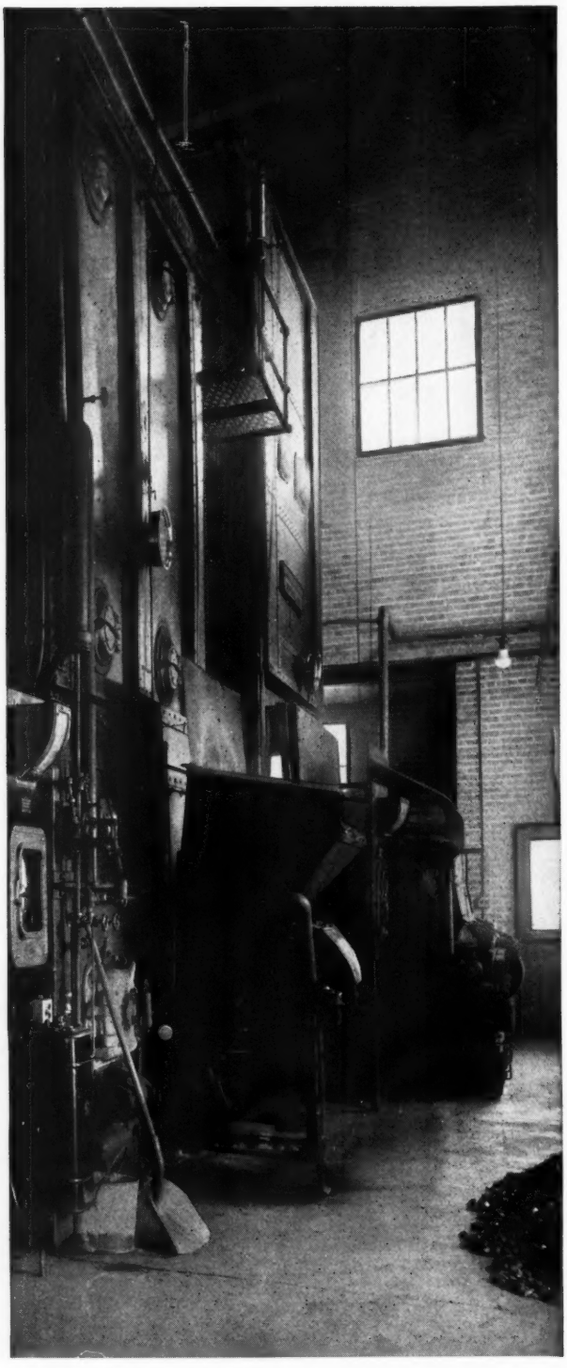
THE BENSON BOILER

By F. Ohlmuller

Other Articles in This Issue By

JOSEPH KEENAN • GEORGE RAMSEY • P. B. PLACE • DAVID BROWNLIE

THIS STOKER PAID FOR ITSELF IN ONE YEAR



Heavy Duty Type E Stoker installed under 354 hp. bent-tube boiler. This stoker burns bituminous coal containing 12,380 B. t. u. as fired. Stoker length 8 ft.— width 9 ft. 1 in.

A year ago a Heavy Duty Type E Stoker was installed under a 354 hp. boiler in the power plant of the City of Alexandria, Alexandria, Minn. It has operated so efficiently since that time that the savings on coal alone have equalled the price of the stoker. Furthermore, the operation of this stoker has been so satisfactory that the other boiler in the plant has been taken off the line and is operated only when the Type E Stoker fired boiler is down for cleaning.

◆ ◆ ◆

The Type E Stoker Catalog describes the features of the stoker which made such performance records possible. May we send you a copy?

COMBUSTION ENGINEERING CORPORATION

200 MADISON AVENUE • NEW YORK

COMBUSTION

VOLUME FOUR • NUMBER SEVEN

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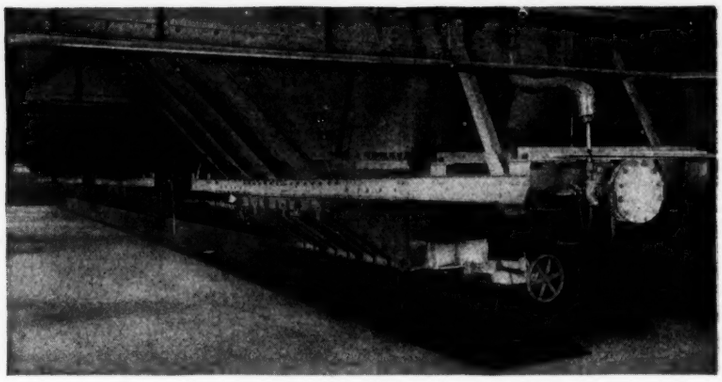

C-E Single-Trough, Water-Sealed Ash Conveyor, Drag Type, serving pulverized-fuel-fired boilers at Mistersky Station

Two C-E Water-Sealed Ash Conveyors, Drag Type, were installed four years ago at the Mistersky Station of the City of Detroit Public Lighting Commission. Each conveyor handles the ashes from four 1000 h.p. boilers. Below is an excerpt from a letter recently received from the General Superintendent of the station.

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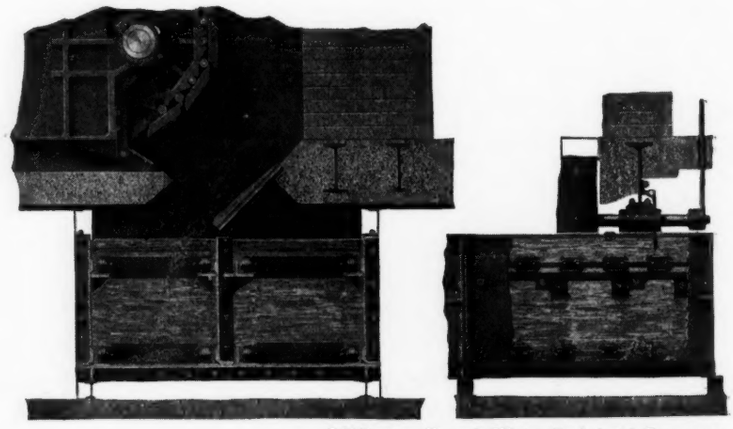

C-E Duplex-Trough, Water-Sealed Ash Conveyor, Drag Type, serving traveling-grate stoker

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Commentary by Joseph H. Keenan

From The Sidelines

I do not usually seek my recreation in technical meetings, but these A.S.M.E. steam research sessions are different. The last one settled all we shall want to know for a long while about the vapor pressure of water. But then, every steam research session has settled some important issue. Once it was the design of a 1/7500th horsepower pump. Osborne needed one for the innards of his little copper-nickel boiler with the gold-gasketed joint. The pump had to be efficient, not just a paddle wheel. And when things got going that pump stood several years of operation, its tiny shaft turning in a water tight packing that sealed against boiling water at 800 pounds per square inch. Failure came only when the time had arrived to build a new apparatus. What more could one ask of any design?

I saw the experimental data start to trickle in as I sat through those December meetings. A few Joule-Thomson coefficients appeared in 1922. In 1923 these measurements from Harvard had worked their way into high pressure regions. Before that we had no experimental knowledge of superheated steam above 250 pounds per square inch, but Davis and Kleinschmidt had now pushed on to almost 600 pounds. Two years later these data reappeared, metamorphosed into a steam table.

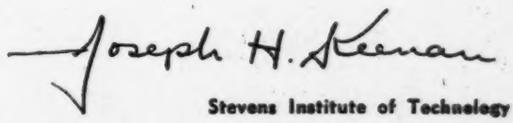
In 1927 Keyes spread before us fifty-two volume measurements of a consistency unprecedented in measurements on superheated steam. The highest pressure investigated was 3900 pounds per square inch, the lowest was 1400 pounds. Here was no hesitating approach to the formidable region of high pressures, it was a bold invasion of its fastnesses. It took some time to coax Keyes and Smith down to the more civilized regions below a pressure of 1400 pounds. They had made measurements at 5200 pounds per square inch and had calibrated their pressure gages up to 8400 pounds before they condescended to enter more prosaic territory. Back in 1927 they had not yet closed the large gap between 600 and 1400 pounds per square inch, but they had triggered off the next steam table development.

Two years later Keyes closed the gap and was proceeding farther on his southerly course. Experimental equipment and technique were being perfected. His first bomb of pure nickel was a source of some annoyance because its walls oozed minute quantities of non-condensible gases into the steam space. It finally ruptured, making way for the use of the more satisfactory stainless steels. The constant temperature bath surrounding the bomb was made ten times as constant, thermometry was improved, the point of separation between the vapor in the bomb and the liquid in the connecting tubes was more sharply defined. And so it happened that a year ago Keyes and Smith told us of a most extraordinary year's work, covering in twelve months the entire range of all their previous experimentation. Suiting equipment and method to each particular region they measured with a precision beyond their own previous performance all the way from 200 pounds per square inch to 5100 pounds. Less spectacular as exploration, perhaps, than some of their earlier work, it was nevertheless the most impressive body of experimental data on superheated steam that had ever been produced in the course of one calendar year.

In the meantime Osborne and his colleagues from the Bureau of Standards were telling us about water and its vapor up to 800 pounds per square inch. Their early descriptions of their methods contained frequent reference to alpha, beta and gamma experiments. But later this Hellenic abecedarianism gave way to the less cryptic discussion of latent heats and enthalpies. They gave us the calorimetric properties of saturated water and its vapor to a precision of one part in 2000, and they deduced through the Clapeyron relation specific volumes of saturated vapor which agreed extremely closely with those reported by Keyes and Smith.

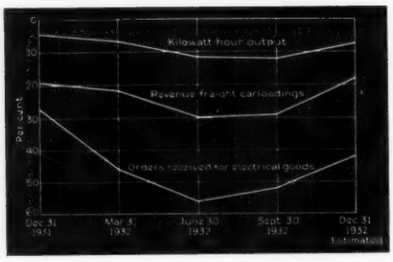
Experimental data from Germany, from England, from Czechoslovakia, analytical studies from everywhere, in fact all the varicolored threads that make up the fabric from which steam tables are made were woven together at the annual meetings.

There are signs and portents foreshadowing an early close of the American steam research program. It should not be so. An organization of skill and experience should not be dispersed until it has acquired all information within its reach. I hope to hear Osborne a few years hence tell us about the specific heat of superheated steam to his usual one part in thousands. I look forward to the reports from Keyes on Joule-Thomson and constant temperature coefficients in the low-pressure range when we need them most. I expect to see him build the structure of the thermodynamic temperature scale which must soon replace the platinum standard. December will remain the prominent month in my calendar, if steam research goes on.



Stevens Institute of Technology

EDITORIAL



The Outlook for 1933

THIS is the question that is uppermost in everyone's mind today. What is ahead of us? Are we facing a continuance of present conditions or are there logical reasons for anticipating better things in the year we are now entering?

Let us consider just a few of the basic factors which collectively justify business in taking a more confident and optimistic view of the situation. The above chart was recently sent out by the General Electric Company with a statement by Gerard Swope, its president. It shows the trend of three of the most fundamental indexes of business in terms of per cent of decrease for each quarter of 1932 as compared with the same quarter of 1931. Mr. Swope's comment was as follows:

"Possibly the best basis for trying to judge the immediate future is the recent tendencies of the past. For that purpose I know of no better index than the use of electricity throughout the United States. This index is the quickest reflection of business activity because when a manufacturer gets an order he starts a motor to run his machinery and turn out the order, and in the household the increased use of light and appliances may be a reflection of a little more employment, or, at all events, better psychology. The accompanying chart shows the percentage relation of each quarter this year with the same quarter of 1931 and indicates there was a decrease in use of electricity in each quarter compared with 1931, but distinct improvement in the last quarter.

"Another excellent index of business activities is freight carloadings. When an order is completed and shipped, it is immediately reflected in carloadings. Here the curve is very similar, showing that the low point was reached in the summer of 1932, with a distinctly upward comparative trend for the last quarter.

"Orders received by the electrical manufacturing industry, as reported to the Department of Commerce (with the fourth quarter estimated), show a distinct trend in the same direction. Therefore, we are hopeful that this comparative trend will continue upwards."

A point of importance in connection with these trends is their contra-seasonal aspect. For example, the peak of the freight car loadings index this past fall was reached several weeks later than normally and the subsequent seasonal decline was much less pronounced. In the latter part of 1931 the trend was in the opposite direction.

Electrical output, one of the most reliable indexes of industrial activity, is now higher than at any time since February of last year and is considerably above the low levels of the late spring and summer months. November figures disclosed, for the first time since 1929, a successive gain over a three-month period.

The recent gains in automobile production have been better than anticipated. Output has increased to almost the highest point in eighteen months, and 1933 production schedules of leading companies are materially better than in 1932.

The credit situation is steadily improving as revealed by recent statements of Federal Reserve member banks. As pointed out in a recent issue of The Financial World, since the end of June total loans and investments have increased only $85,000,000 whereas time and demand deposits have increased by $900,000,000. Thus a large fund of liquid resources has been created which must seek employment in trade and industry.

While the international debt situation continues to be a barrier to improved world trade, we have reached a point where the problem must be solved without further delay. The attitude of the United States is perhaps the most important factor affecting solution and it will therefore be advantageous to have our views and plans presented by the representatives of a new administration which to a large extent will be unfettered by the policies and plans proposed by previous negotiators. In complicated proceedings of this character a fresh approach and new viewpoints are of great aid in avoiding old impasses. With such an approach, with the universal demand for a solution that will remove the impediments to resumption of world trade and economic stability, which the debt problems constitute, and with an increased determination on the part of all concerned to develop an acceptable plan—there is substantial basis for the expectation that real progress will be achieved at the forthcoming conferences.

These basic factors all appear to favor a continuance and acceleration of progress in the direction of recovery. There are many isolated factors which will further contribute to it. Practically all business enterprises have reached new levels of economic operation, so much so that even a small increase in volume will change their ledger figures from red to black. Skeleton organizations

(Continued on page 10)

Fig. 1—Boiler room of Northeast Station. The unit converted to pulverized fuel firing is shown in the foreground. Chain grate and multiple retort underfeed stokers are also used in this plant.

Burning Pulverized Petroleum Coke Breeze

By

E. J. McDONALD, Efficiency Engineer

Kansas City Power and Light Company

The Northeast Station of the Kansas City Power & Light Company has burned in pulverized form over 116,000 tons of petroleum coke breeze. Numerous tests have been conducted to determine the burning characteristics, efficiency, capacity, mill power, etc., when burning this fuel. This article includes a general description of the unit on which the tests were conducted and a summary of the more important information derived from these tests.

SINCE this article is based on experiences in burning pulverized petroleum coke breeze at the Northeast Station of the Kansas City Power & Light Company, the first few paragraphs will be devoted to a brief description of this plant and its development to date.

The first section of Northeast consisted of three 20,000-kw., 250-lb., 650-deg. turbines, the first unit going into service in the latter part of 1919. The 1350-hp., 300-lb. pressure boilers (shown in the foreground of Fig. 1) equipped with both high- and low-pressure economizers, induced draft fans, double chain-grate stokers, and water-sealed ash pits permitted Northeast to be properly classed at the time as—a most modern plant.

Throughout the intervening years additional equipment has been added to keep Northeast in this class. Two 30,000-kw. turbines, additional forced-draft chain-grate stokers, air preheaters, and radiant-heat superheaters not only increased plant capacity but efficiency as well. In recent years, Northeast has probably become better known as one of the pioneers in 1400-lb. equipment through the early installation of a 10,000-kw., 1250-lb. turbine with two 2000-hp., 1400-lb., completely water-cooled, pulverized-coal-fired boilers. The significance of all this is perhaps best expressed in the following statement of operating results:

1920 performance, minimum monthly average—21,400 B.t.u. per kw-hr.

1932 performance, minimum monthly average—14,636 B.t.u. per kw-hr.

So today, some 13 years since its conception, Northeast Station with its present 140,000-kw. installed capacity can still be considered—a most modern station. So much for the plant, a little more description of which is included elsewhere in this article.

Obviously, these steps of progress have brought with them new problems in operation. This is particularly true in the boiler room where zone-controlled, forced-draft stokers followed the old natural- or induced-draft type of stoker and pulverized fuel equipment followed the forced-draft installation. Such an array of equipment, together with the wide variety of fuels available (bituminous, semi-anthracite, Arkansas anthracite, and petroleum coke breeze) has created many problems in fuel burning, resulting in numerous tests and experiments to determine the proper equipment for the various fuels and the most efficient manner of burning. One of these problems has been the burning of petroleum coke breeze, available to this station from the Kansas, Oklahoma, and Missouri refineries.

Nature and Production of Petroleum Coke Breeze

Petroleum coke is the carbon deposit removed from certain stills in the cracking process of oils. It has the spongy appearance of coal coke but is of a more fragile and oily nature. The lump and nut are usually screened out and sold for domestic heating; the remainder is called "breeze." As the material is fragile, it disintegrates easily, and the breeze contains a large percentage of "fines."

It may be well to emphasize here that the expression "coke" or "coke breeze" should always be qualified; that is, expressed as coal coke or petroleum coke. There is a tendency to confuse and there is considerable difference in the character and usage of these two fuels.

TABLE 1

Typical Analyses of Petroleum Coke Breeze Received at Northeast Station

Ultimate Analysis (Dry)		Proximate Analysis (As Rec'd)	
Carbon	92.06%	Moisture	5.50%
Hydrogen	4.14	Fixed carbon	87.60
Oxygen	.67	Volatile	5.82
Nitrogen	.90	Ash	1.18
Ash	1.26	B.t.u.	15,000
Sulphur	.97		
B.t.u.	15,886		

The quality of petroleum coke can vary considerably, depending on the oil from which it is derived and on the method or degree to which this oil is refined. Table 1, however, shows a typical analysis of the "breeze" supplied as a commercial fuel and makes evident its general characteristics.

The Bureau of Mines publication on "Coke and By-Products in 1929" shows the total production of petroleum coke has increased from 560,000 tons in 1918 to 1,820,000 tons in 1929, its greatest single use being as a fuel at the refineries and the second largest use as a domestic fuel for homes. With the general acceptance of the pulverized form of fuel burning, petroleum coke breeze has increased as a fuel for industries and power plants, and in the past few years, at least one modern power plant has been built adjacent to a large refinery and its furnaces designed principally for the use of this fuel.

While petroleum coke has been burned on stokers, it is obvious that its high percentage of "fines" would result in a great amount of siftings through the loosely constructed natural-draft stoker grates, its low volatile would make ignition difficult, and the low ash content would offer little protection to either this or the forced-draft type of stoker, resulting in excessive maintenance. A mixing of coke breeze with a high ash, low B.t.u. fuel would appear to be the solution and while this has been done, it is generally recognized that the mixing of two fuels for stoker use is not an entire success. Petroleum coke breeze can, however, be very successfully burned in pulverized form. That is the manner in which most of it is consumed and the manner in which it has been burned at the Northeast Station, over 113,000 tons being consumed in a refractory-lined furnace and about 3000 tons in a completely water-cooled furnace. As the greater tonnage was consumed in the former, a description of this unit will be presented.

Description of Refractory-Lined Furnace Unit

When the unit mill pulverizer was finding its way into the modern power plant, Northeast converted one of the original stoker units into a pulverized fuel unit to determine the merit of this form of fuel burning when applied to mid-western bituminous, semi-anthracite, Arkansas anthracite, and coke breeze. Fig. 1 shows the original stoker units and the converted unit, Figs. 3 and 4, showing them in cross-section, will make evident the major changes.

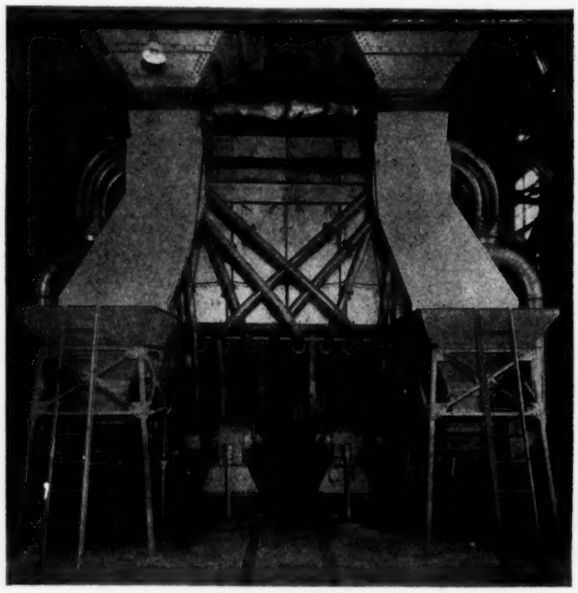


Fig. 2—View of revamped unit showing how burner pipes are crossed to assure uniform firing when one mill is out of service.

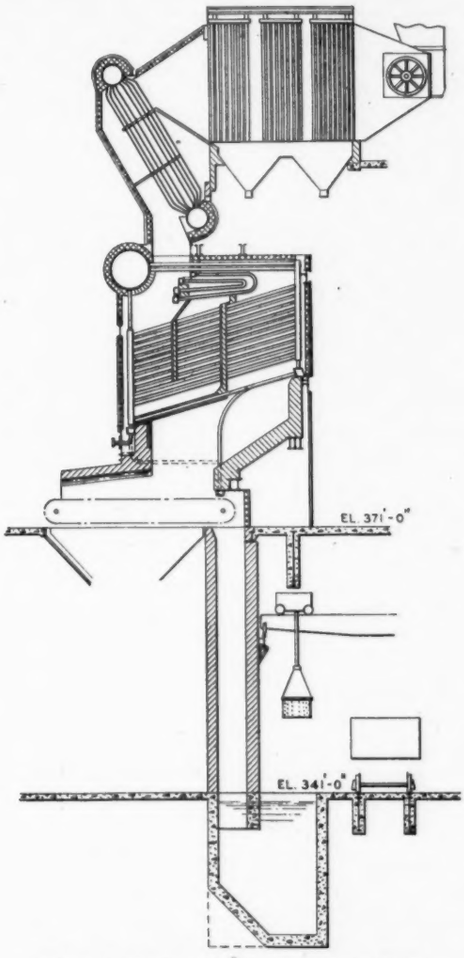


Fig. 3—Sectional elevation of original stoker unit.

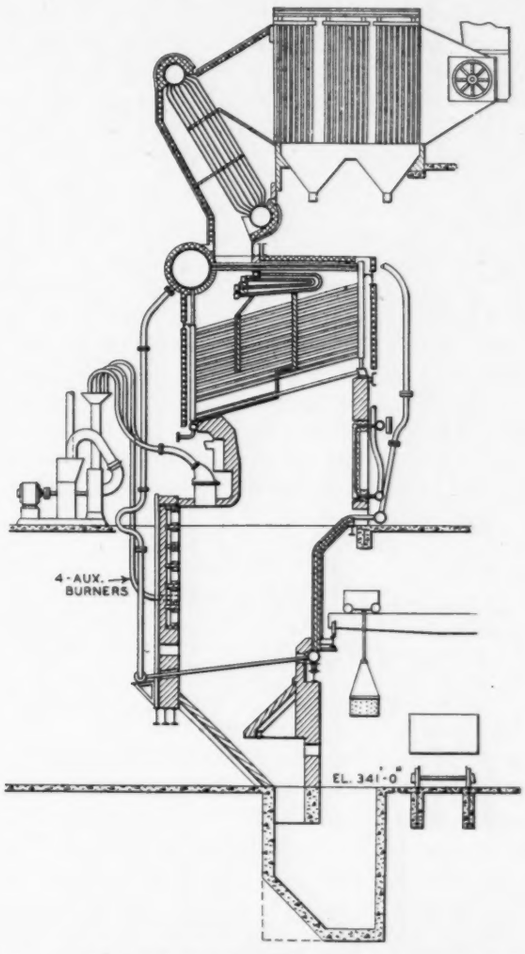


Fig. 4—Sectional elevation of unit as revamped for pulverized fuel firing.

Existing building steel limited the size and shape of the remodeled unit and did not permit the most desirable form of construction; however, by removing the stokers, sifting hopper, and ash chute, a furnace was obtained with a height of 30 ft. from the water screen to the boiler tubes, a depth of 16 ft., (front to rear) and a width of 21 ft. in the lower section, and 24 ft. in upper or original furnace, giving a furnace volume of 10,200 cu. ft. or 7.55 cu. ft. per rated hp. This results in a liberation of 15,500 B.t.u. per cu. ft. when burning coke breeze at normal rating (112,000 lb. or 275 per cent), compared with 40,000 B.t.u. per cu. ft. when burning coal at normal rating (90,000 lb. or 225 per cent) in the original stoker furnace where only 4.2 cu. ft. was available per rated hp.

In addition to a water screen, the remodeled unit contains a fin-tube rear wall, and directly above this wall a radiant-heat "booster" superheater in series with the original convection superheater.

Primary air is heated by passing over the main arch and through a duct back of the curtain wall, entering the pulverized coal mills at about 160 fahr., approximately 20 per cent of the air passing through the mills. This acts as a partial drying medium for the fuel, there being no external dryers. Secondary air enters at the rear of the air-cooled, tile sidewalls, passing through six dampered zones to the front tile wall and entering at about 140 fahr. through slotted openings below each burner.

Two No. 80 Raymond Impact unit mills (with integral fans), each rated at 5-ton capacity when pulverizing 9700-B.t.u. bituminous coal with 20 per cent ash and 13 per cent moisture, supply a total of eight Lopulco burners and four auxiliary burners later installed for turbulence near the bottom of the front furnace wall. Figs. 2 and 4 show this arrangement, the former also showing the staggering of burner pipes from each mill to permit a fairly uniform fire when only one mill is in service.

Ash from this unit drops through the water screen to the same water-sealed pit formerly used by the stokers, from which it is removed by a clam-shell bucket and deposited in standard coal cars for disposal as shown in the cross-sections, Fig. 3 or 4. A summary of the more important factors in pulverizing and burning petroleum coke breeze in this unit follows.

Performance of Petroleum Coke Breeze Compared With Bituminous Coal

Table 2 shows the results of an 8-day (192-hr.) continuous test, which is typical of a number of other tests conducted on the unit described.

Approximately 21,383,000 lb. of water were evaporated during this particular test, or an average of 111,360 lb. per hr., which equals 274 per cent of boiler and superheater rating.

The normal rating when stoker fired was 225 per cent, and when burning bituminous coal in pulverized form, 240 per cent. The maximum rating with 10,000-B.t.u. bituminous coal on the original stokers was about 275 per cent; burning this same coal in pulverized form, 320 per cent, and with coke breeze, 375 per cent. The latter was the limit at which water could be fed to the boiler.

The unit efficiency over the entire 192-hr. period averaged 84.78 per cent or deducting fan and mill power, 83.64 per cent. These figures represent "normal operating" efficiencies, the unit running continuously and receiving only the normal amount of attention or cleaning during the period. This is about 4.5 per cent higher than obtained with bituminous coal fired on the original stoker unit, or about 3 per cent higher than bituminous coal fired in the same pulverized fuel furnace under normal operation.

The heat balance, Table 2, on the 192-hr. test shows the various losses when burning petroleum coke breeze. The air-cooled furnace helps account for the low radiation loss shown.

Pulverizing Mill Performance With Petroleum Coke

An evaporation of 82,000 lb. per hr. (205 per cent rating) has been obtained from one mill, pulverizing 10,500-B.t.u. bituminous slack containing 18 per cent ash and 10 per cent moisture.

An evaporation of 148,000 lb. per hour (375 per cent rating) has been obtained from one mill pulverizing 15,000-B.t.u. petroleum coke breeze, containing 1.5 per cent ash and 3.5 per cent moisture.

The above figures represent approximately 11,600 lb. per hr. of bituminous slack and 14,700 lb. per hr. of coke breeze. The higher pulverizing rate with the latter is due to the lower moisture and ash content and the more fragile structure of the material. In this respect petroleum coke differs materially from coal coke. While both are of a porous structure, the latter is a harder and more abrasive fuel, the breeze running around 13,000 B.t.u. and 9 per cent ash on a dry basis.

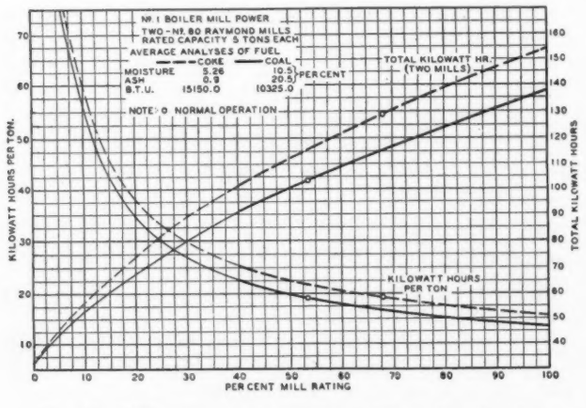


Fig. 5—Mill power consumption with coal and coke.

TABLE 2

192-Hour Pulverized Petroleum Coke Test, No. 1 Boiler, Northeast Station

OBJECT: To determine performance when burning petroleum coke breeze under normal operating conditions.

DURATION: 192 hours.[1] The average for the entire period is tabulated; also 24-hour minimum and maximum to show variation from average.

FUEL: Petroleum coke breeze from Ponca City, Okla.

Analysis as received:

Moisture	Ash	B.t.u.	B.t.u. Dry
4.3%	1.45%	15,118	15,800

For typical ultimate and proximate analyses see Table 1.

2,000,064 lb. in 192 hr.	Daily Minimum	Daily Maximum	Average For 192 hr.
Lb. fuel per hour	10,000	10,833	10,417
B.t.u. liberated per cu. ft of furnace	14,920	16,140	15,440
WATER: 21,383,000 lb. evaporated in 192 hr.			
Actual evap. per hour	108,439	116,464	111,366
Evap. per lb. fuel	10.32	11.14	10.69
Factor of evap. overall	1,230	1.242	1.235
Equiv. evap. overall	12.71	13.76	13.20
Temp. into low press. econ. (deg.)	174	184	179
Temp. out of low press. econ. "	207	215	212
Temp. into high press. econ. "	204	210	207
Temp. out of high press. econ. "	257	263	260
FLUE GAS:			
Temp. outlet boiler	540	558	550
Temp. outlet h.p. econ.	360	372	365
Temp. outlet l.p. econ.	297	307	301
Temp. air to mills	155	165	160
CO_2 outlet l.p. econ.	...	...	13.0%
CO outlet l.p. econ.	...	...	0
O outlet l.p. econ.	...	...	6.7%
Furnace draft (inches)	.05	.06	.06
STEAM:			
Press. outlet superheater (lb. gage)	285	291	288
Temp. outlet superheater (deg.)	658	675	661
Degrees superheat	237	257	243
HORSEPOWER:			
Developed by boil. & superheater	3590	3875	3700
Developed by overall unit	3880	4200	3988
Mor mills & ind. draft fan	....	....	49
Net	....	....	3939
% rating by boil. & superheater	....	....	274
EFFICIENCIES:			
Boiler and superheater			78.50%
Boiler, superheater and high pressure economizer			82.45%
Boiler, superheater, high and low pressure economizers			84.78%
Deducting auxiliary power			83.64%
HEAT BALANCE:			
Heat absorbed by unit			84.78%
Loss due to moisture in coke			.30%
Loss due to burning of hydrogen			3.00%
Loss due to dry stack gases			5.97%
Loss due to combustible in ash			4.00% [3]
Loss due to moisture in air			.30%
Loss due to radiation and unaccounted for			1.65% [4]

[1] Boiler operated continuously, receiving normal attention and cleaning.
[2] Includes rise through both convection and radiant superheaters. This is about 15 deg. lower than with coal.
[3] Practically all this loss is in fly ash.
[4] Air cooled furnace reduces radiation losses.

Mill power, expressed in the term commonly used—"per ton pulverized," is about the same for coal and coke when each is operating at its respective normal rating. From this it would appear that the grindability of the two fuels were equal; actually this is not the case. Coke is more fragile and its grindability higher, all of which necessitates some explanation.

Coke with its higher heat value requires the pulverizing of less tons for normal rating than coal, resulting in the mills operating at a lower capacity and a lower efficiency, thus increasing the kw-hr. per ton of coke even though the actual power for

pulverizing is less. The curves in Fig. 5 show this and also the true comparison—"total" kw-hr. of mill power required for either coal or coke.

Incidentally, these curves make evident the possible error in comparing the mill power required by two fuels on the common basis "kw-hr. per ton" or even on a basis of "kw-hr. per million B.t.u." The rate of pulverizing or condition of hammers frequently has as much bearing on power as a marked difference in the character of the fuel.

Hammer wear with petroleum coke is about one-fourth of that with coal, averaging 7497 tons per set of hammers, compared with 1726 tons when pulverizing bituminous coal of the analysis previously quoted. The reason for this great difference is, as previously explained, low ash, low moisture and fragile structure.

Burning Characteristics of Petroleum Coke Breeze

Petroleum coke contains a low volatile; hence, a closely balanced draft and a hot furnace must be maintained to assure good ignition. For this same reason, it requires closer attention than coal, particularly if used for swing purposes, and while several thousand tons have been burned in the completely water-cooled furnaces, the refractory-lined furnace permits better ignition and fire conditions. This deficiency has been overcome in certain installations by burning coke in combination with some other fuel, usually oil or gas.

Less excess air is used with coke than with coal, resulting in a higher CO_2 (15 to 16 per cent at boiler outlet) and less gas weight. While this is a saving in stack losses and fan power, it results in a loss of superheat where convection superheaters are used.

The combustible loss in petroleum-coke fly ash increases with rating, similar to coal, and for this particular installation the economical limit is about 275 per cent of rating.

Coke has been received with 10 to 11 per cent moisture, but trouble is experienced with anything above 7 or 8 per cent due to a heavy rain of sparks and lowered mill capacity; hence, these figures have been set as the maximum moisture for burning.

Coke with an oil content up to 12 per cent has likewise been received but a high oil content is very undesirable as it results in carboning and overheating of the burners. In some cases the burners have become red hot for one to two feet from the tip, causing them to coke and plug up.

Practically all of the petroleum coke received has been from cracking stills which produce a coke of fragile structure; however, some coking-still coke has been burned which is of a harder and more abrasive structure, resulting in higher pulverizing costs. This, together with its lower volatile which retards ignition, makes it a less desirable fuel.

Relative Value of Coal & Coke

The value of any fuel is, of course, "relative," that is, it is worth so much more or so much less than some other fuel for some specific purpose. Obviously, then, the comparison shown here refers only to these particular fuels and equipment; however, it will serve as an indication of what to expect under other conditions. Summing up the major factors that determine the relative efficiency of coal and coke in this particular instance, we find the net efficiency of coke is:

3.00%	higher due to boiler unit efficiency
.60%	higher due to lower draft fan power
.40%	higher due to lower mill and induced draft fan power
.65%	lower due to lower superheat
3.35%	net difference

With coal at 81.78 per cent efficiency (3 per cent below coke), the value of the latter would be $\frac{3.35}{81.78}$ = 4.1 per cent more than coal, considering only efficiency. The saving due to lower mill maintenance would increase its value 3.6 per cent or a total of 4.1 + 3.6 = 7.7 per cent more could be paid for coke than for coal on a *B.t.u. Basis.*

If the relative value of coal and coke is considered on a ton basis, the difference in heat value must, of course, be considered. For the particular fuels in question, the value of coke would be $\frac{15{,}100 - 10{,}500}{10{,}500}$ = 43.7 per cent higher than the coal, making one ton of coke worth 7.7 + 43.7 = 51.4 per cent more than one ton of coal.

In a similar manner some additional credit could be given coke for less boiler cleaning, less fuel and ash handling, and higher boiler capacity. At Northeast Station the first two items represented a small credit per ton and the third item could not conscientiously be considered because of the reserve boiler capacity existing in the plant; however, any of these items may be of more importance in some other installation. In addition to these advantages petroleum coke (when cooled) has the qualifications necessary for long storage without spontaneous combustion or weathering losses, namely, low volatile, low sulphur, and low percentage of impurities. This may have value in some instances.

So far it would appear that petroleum coke breeze has many advantages over coal, i.e., higher efficiency, lower fan and mill power, lower pulverizing costs, considerably higher heat value, etc. However, in order that a true comparison may be made, there are certain other items that should be considered. These will be enumerated and each briefly discussed.

Continuity of Supply. As petroleum coke is a by-product, its production is dependent on the sale or demand for other products; hence, the continuity of supply may be frequently interrupted. No single refinery is capable of supplying a large con-

tinuous tonnage. Changes in refining methods may influence the future supply.

Uniformity of Quality. As previously stated, the quality of petroleum coke can vary excessively depending on the oil and method or degree of refinement. Such variations affect both mill and boiler capacity.

Due to the method of removing the coke from the stills, pieces of cable, chain or beater balls frequently find their way into the shipment and unless magnetic separators are used may cause damage or a temporary shut-down of a pulverizing mill. These conditions do not permit placing the same dependency in coke as in coal—with full appreciation for the fact coal can likewise vary in quality.

Type of Equipment. It would not be advisable to consider coke alone as a fuel for stokers; likewise it is not a highly desirable fuel if burned alone in a bare-tube, water-cooled furnace where the low furnace temperature makes difficult the sustained ignition of this low-volatile fuel except at high rates of combustion. It is best suited for a refractory-lined furnace and even here low rates of combustion are not easily maintained.

Value of Superheat. Where convection superheaters are used, petroleum coke will produce a lower superheat. If this affects economy only, it can be compensated for by a lower fuel cost; if a definite steam temperature is required, additional surface must be installed.

Value of Increased Boiler Capacity. Where there is ample reserve boiler capacity installed it would be difficult to capitalize on the higher capacities made available by burning petroleum coke breeze; however, in some instances the ability to get 20 or 25 per cent more capacity may eliminate the necessity of a new boiler, and petroleum coke breeze could be properly credited.

Delivered Price at the Boiler Plant. In many cases distance or the higher freight rate would make petroleum coke breeze non-competitive with local coals; however, a balance of the various factors mentioned should be made to determine its value. In the final analysis it is the relative delivered price of coal and coke in millions of B.t.u. that counts.

Conclusions

Throughout this article some variance may have been noted; for example, different heat values of fuel have been quoted. Obviously this is the result of using the actual analysis obtained in the particular case and not some arbitrary set of figures. The principal intent of the article has been to bring out both the advantages and disadvantages of petroleum coke breeze so those interested in the possible burning of this fuel may have some basis on which to judge its value. Whether it is a desirable or economical fuel will, of course, depend on a balance of the factors mentioned, and obviously these will vary not only with local conditions but with periods of time.

Petroleum coke breeze, as with any other fuel, may be economical today and uneconomical tomorrow, the chief factor of variance being its availability and the delivered price of competitive fuels. Two factors, however, remain constant, namely—petroleum coke breeze can be easily pulverized and very successfully burned in the proper type of furnace.

The Outlook for 1933

(*Continued from page 4*)

are the order of the day and consequently any improvement in business will immediately result in increased employment. Many manufacturers have developed new lines and greatly improved standard products. At the same time obsolescence of equipment has been permitted to continue to a point where a large volume of replacement business is in sight. Even equipment which meets present-day standards of efficiency has not been kept in repair and repair part stocks have not been maintained. An example of this has come to our attention within the past month. A manufacturer received a rush order placed on a penalty basis. It had just been started through his plant when some boiler tubes ruptured. No spare tubes were in stock although the boiler was a high-pressure unit and tubes could not be procured quickly. An order was phoned to the manufacturer who advised that it would take a week or ten days to get tubes to the plant. As a result a considerable penalty will be incurred.

It is commonplace knowledge that manufacturers have kept production units in repair by dismantling units not in current use. This process has been going on for some time and with a demand for increased production there will be numerous incidents like the above. The results will be painful and costly but they will also lead to a substantial improvement in repair part business.

It is a matter of history that periods such as the one from which we are emerging are particularly conducive to new industry. Today we see the air-conditioning industry, with its tremendous potentialities, just coming out of its swaddling clothes. The brewing industry appears to be about to stage a comeback. Recent developments in metallurgy and in building construction hold promise of large and profitable enterprises.

All in all the picture, as we see it, is decidedly encouraging. What we need most of all is a renewal of confidence, not of a Pollyanna type but based on a common-sense analysis of the present situation and what it portends for the near future. Confidence that will lead bankers to make use of their vast liquid resources in supplying credit for industrial rehabilitation. Confidence on the part of manufacturers that money spent for putting their plants in first-class operating condition will be money well invested. Confidence on the part of the retailer that the time has come to stock up on his depleted inventories. Such confidence permeating all parts of the business structure will do much to make the depression a matter of history.

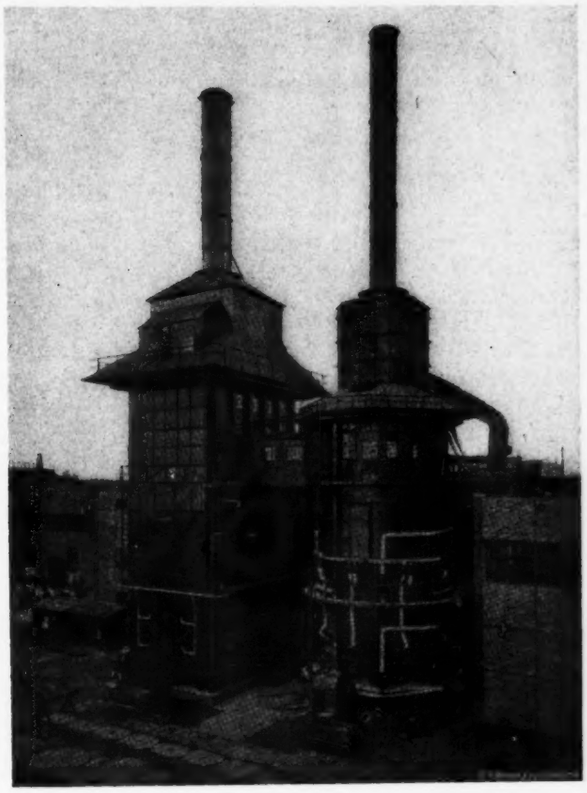


Fig. 1—Benson boilers, Nos. 1 and 2, at the Cable Works, Berlin-Gartenfeld.

The Benson Boiler

By F. OHLMULLER, Chief Engineer

Siemens-Schuckertwerke, A.-G.

Berlin, Germany

This article is a translation of a paper read by Mr. Ohlmuller before the Engineers German Circle, London, October 10, 1932 and published in the November issue of our British contemporary "The Steam Engineer." It reviews development of the Benson boiler, both land and marine types, from the time of its invention to date. It also describes and gives operating experiences of the principal installations. The Benson boiler together with the Loeffler and Schmidt boilers are among the most interesting and important designs that have been developed for the generation of steam in the so-called superpressure range. COMBUSTION published a review of the development of the Loeffler steam generator in October of this year and will shortly publish an article on the Schmidt boiler.

THE Benson boiler was invented about ten years ago by Mark Benson, who then founded the "Benson Engineering Co., Ltd.," in London for its development, where his engineers designed the first test boiler, which was later installed in the works of the English Electric Co. at Rugby.

Prior to the erection of this boiler, however, Siemens-Schuckertwerke of Berlin, Germany, had secured by agreement the exclusive rights of using the patents, and it was under their supervision, in close co-operation with some English engineers, that the boiler at Rugby was actually erected and tested.

For the further development of the invention, a new company, named the "Internationale Bensonpatent-Verwertungs-A.G." was founded in Switzerland jointly by Siemens-Schuckertwerke and the Benson Super Power Corporation, an American company for the holding of Mr. Benson's interest. The engineering part of the Swiss company's work was placed entirely in the hands of the Siemens-Schuckertwerke. Subsequently the English "Benson Engineering Co., Ltd." was dissolved.

The test on the Rugby boiler, that was carried out during the year 1924, soon proved that the basic ideas of the Benson system were correct, *i.e.*, that dry steam could be generated in the boiler and perform useful work in a turbine. The purpose of this first installation thus being fulfilled, the tests at Rugby were abandoned at the end of the year 1924. The boiler is still there, although it has never been in operation since. Occasionally

it is shown to visitors at Rugby as an object of historic interest, but it may perhaps be used at a later date for testing purposes in an English research laboratory or by a prospective licensee in this country.

Description of the Benson Process

The Benson boiler generates steam at the critical state (3,200 lb. per sq. in. pressure, 706 deg. fahr. temperature) where the latent heat, which decreases when the pressure rises, becomes zero, and the water is suddenly converted into steam of the same volume. Below the critical temperature the contents of the boiler is water, above that temperature it is superheated steam. Thus, strictly speaking, a Benson boiler only consists of an economizer and a superheater.

The most typical feature of regular boilers, viz., the drums, are missing in a Benson boiler, since there is no mixture of water and steam to be separated. There is also no natural circulation by means of return tubes, but rather a straight forced flow of the medium through a continuous tube or bundles of tubes.

At the critical point the specific volume of the steam is approximately three times as large as that of cold water and it increases rapidly as the steam becomes superheated. As compared with lower pressures, however, this steam is still very dense, *e.g.,* at 869 deg. fahr. the specific volume of 3,200-lb. steam is 12 times that of cold water, whereas steam of 200 lb. has a specific volume 240 times greater than water.

First Test Boiler in Germany

Encouraged by the success of the test boiler at Rugby, the Siemens-Schuckertwerke soon decided to build another Benson boiler in one of their own plants at Berlin-Siemensstadt. This second boiler, however, was not an entirely new Benson boiler, but rather an existing 170 lb. per sq. in. longitudinal drum water-tube boiler lifted as much as the building allowed and equipped with Benson tube elements placed horizontally in the enlarged furnace below the old boiler, which then served as an economizer. The old chain grate stoker was replaced by oil firing for the sake of easy regulation.

The tests with this boiler proved that it was feasible to improve old low-pressure boilers by simply adding small amounts of critical pressure heating surface, a solution which at that time was much favored because of the general tendency towards saving in first cost. Later, however, it was found to be more economical—thermally and financially—to erect entirely new units designed to operate under critical pressure.

First Commercial Installation in the Cable Works, Gartenfeld

The first opportunity for building a new Benson boiler was offered in the cable works of the Siemens-Schuckertwerke at Berlin-Gartenfeld, where the increasing steam load for heating and process work made it necessary to provide for an extension of the existing low pressure boiler plant. It was decided to erect a Benson boiler of approximately 60,000 lb. per hour capacity together with a back pressure turbine for delivering by-product power.

This boiler, besides being the first commercial installation and of a relatively large size, is interesting in still other respects, since it involved many new features of design, which had no direct bearing on the Benson system.

First of all, the traditional boiler shape inside a boiler room was abandoned, and the boiler was erected in the open air, forming the boiler house itself. In the center, a vertical cylindrical shaft, entirely water cooled, constituted the combustion chamber. It was surrounded by eight flue passes in a concentric annular space which gave the boiler an octagonal shape. In these flues were placed the convection heating surfaces and plate-type air preheaters, the whole boiler being insulated on the outside by means of double walls, through which the air for combustion was forced before entering the preheater. Pulverized-coal firing was provided with extremely high air preheat temperatures (750 deg. fahr.).

Second Cable Works Boiler

Soon after the first Benson boiler had been put into operation, the cable works ordered a second boiler of the same kind, but for a 50 per cent larger capacity, to meet the steam demand which had again increased.

This second boiler, although being built gener-

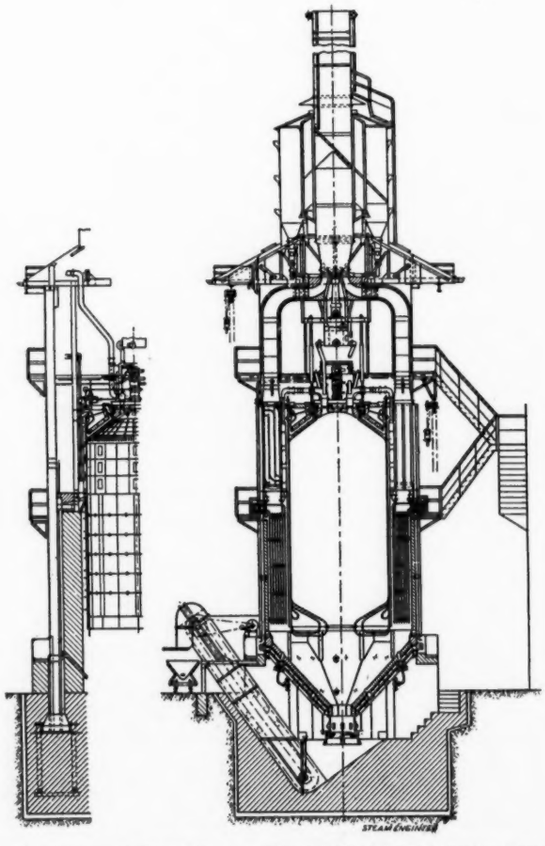


Fig. 2—Benson boiler No. 1 at the Cable Works, Berlin-Gartenfeld, capacity 50,000 lb. per hr.

ally along the same lines as No. 1, embodied some essential improvements based on the experiences gained in the meantime. The combustion chamber is cylindrical in the upper part but square shaped in the lower part, and there are only two flue passes on two opposite sides of the combustion chamber, thus giving the boiler a rectangular cross-section instead of the octagonal shape of No. 1.

The combustion chamber is approximately 15 ft. wide and 26 ft. long with four pulverized fuel burners on top. It is completely lined with heating tubes, which were not arranged straight as in No. 1, but were helically wound in order better to compensate any uneven heat distribution.

At the bottom of the furnace, the flue gases turn around sharply, and at the same time deposit most of their ashes in the water-sealed hopper, from where they are dredged out at intervals. The flue gases then pass the convection heating surfaces, such as superheaters, conversion zone, economizers, all made up of helically wound coils, then the plate-type air preheaters and finally the electric dust precipitators. The two streams of flue gases are then joined above the boiler and discharged through a propeller-type induced draft fan to the stack. The air is taken in through the hollow outer walls and then preheated in the air preheaters to 750 deg. fahr.

After the first troubles, unavoidable with new installations of that kind and size, had been overcome, both Benson boilers of the cable works have worked satisfactorily. During the last heating season boiler No. 2 has been in continuous operation practically without any trouble.

Langerbrugge-Benson Boiler

In a layout similar to the second cable-works boiler, another Benson steam generator was then built for the Langerbrugge station of the Centrales Electriques des Flandres et du Brabant. The boiler was also erected in the open. The flow of air, flue gas and pulverized coal is illustrated in Fig. 4.

Except for the fact that the combustion chamber is square-shaped over its entire length, and that Ljungström air-preheaters were used instead of plate-type air-preheaters, the boiler differs only in size from No. 2 of the cable works, being approximately two-and-a-half times larger. This, however, meant quite a step in unknown regions and was largely the reason for a number of minor troubles that occurred in the course of the first years and against which various measures had to be undertaken, until finally, at the present time, the boiler is operating satisfactorily.

Among the measures referred to was the changing of the flow of water and steam through the boiler in such a manner as to insure the conversion zone being removed from direct radiation and placed in the convection zone, where the gases are cooler. Another measure was the adding of a water screen at the bottom of the furnace. This, however, was only due to the fact that the station had to use coal with a lower ash fusing point than originally intended, which has, of course, nothing to do with the Benson system proper.

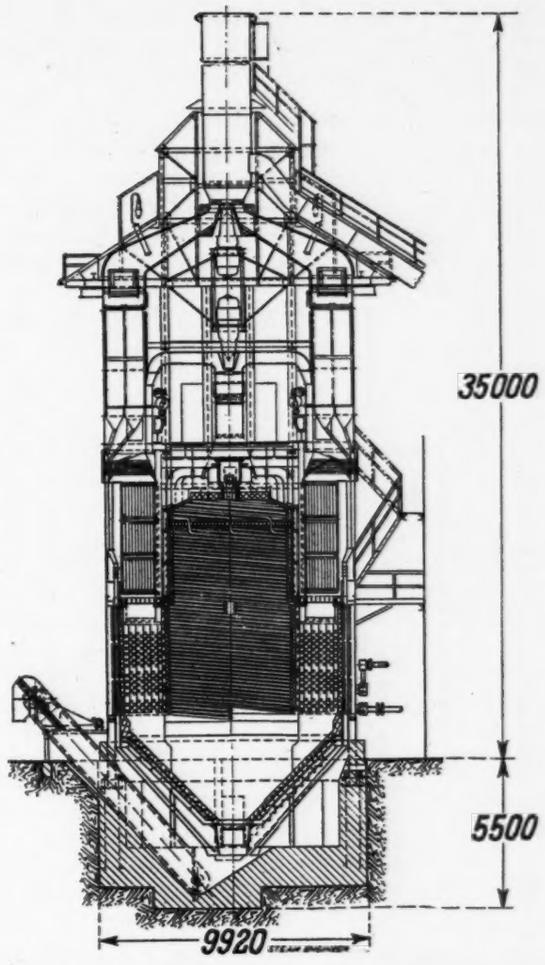


Fig. 3—Benson boiler No. 2 at the Cable Works, Berlin-Gartenfeld, capacity 80,000 lb. per hr.

As the result of the above-mentioned and other smaller changes that were undertaken during the last year, all troubles are now overcome and the boiler has been in satisfactory operation for months.

The steam generated in the Benson boiler first expands in a 4,000-kw. high-pressure turbine from 2,850 lb. 840 deg. fahr. to approximately 750 lb., is then reheated in the boiler and finally delivered to the station main. The high-pressure turbine drives the feed pump for the Benson boiler as well as a generator which delivers approximately 2,500 kw. at full load.

Benson Boilers with Chain-Grate Stokers

Although all Benson boilers built so far were oil or pulverized coal-fired, it may be pointed out that for future installations chain-grate stokers are also contemplated, for which detailed designs have been worked out. (See Fig. 6.)

Benson Marine Boilers

As a forerunner of the Benson marine boiler a small test boiler, having a capacity of three tons per hour, was erected five years ago in the laboratory of Professor Josse at the "Technische Hochschule" of Charlottenburg, where it serves for

demonstrations to students and for test and research purposes. At present a small high-pressure steam turbine is being built to use the steam from this Benson boiler.

In 1930 Messrs. Blohm and Voss of Hamburg, after having acquired the exclusive license for building Benson marine boilers in Germany, equipped the 6,000 b.hp. steamer *Uckermark,* of the Hamburg-American Line, with a 20-ton-per-hour Benson boiler (described in THE STEAM ENGINEER, February, 1932).

The *Uckermark,* as well as her sister ship *Kurmark,* received their engine and boiler-plant from the ships of the *Albert Ballin* class, which at that time were fitted with machinery of larger output. In the original design the boiler plant consisted of two double-ended and two single-ended Scotch boilers for a pressure of approximately 200 lb. per sq. in. On the *Uckermark* one of the two double-ended boilers was replaced by a Benson boiler, and a new high pressure turbine was added to the regular low-pressure turbine installation. From the fact that the Benson boiler supplies the same amount of power as would otherwise have been produced by the four Scotch boilers, the enormous saving of floor space and weight becomes evident.

The construction of the boiler can be seen from the accompanying isometric view (Fig. 5). At the left is the combustion chamber with water walls at the two long sides and the oil burners in the front walls. The gases then flow downward through the second pass (in the middle) and again upward in the third pass (at the right), along the last convection heating surface and through the air preheater to the stack.

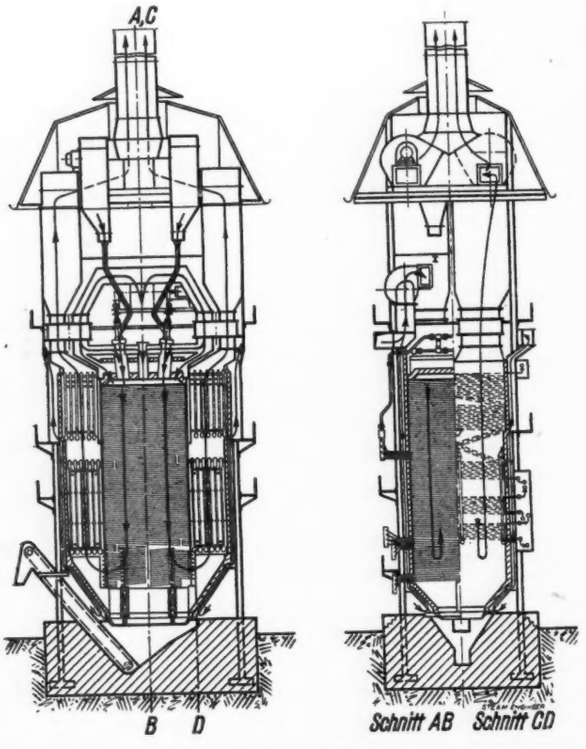


Fig. 4—Benson boiler at Centrales Electriques des Flandres et du Brabant, Langerbrugge, Belgium, capacity 200,000 to 240,000 lb. per hr.

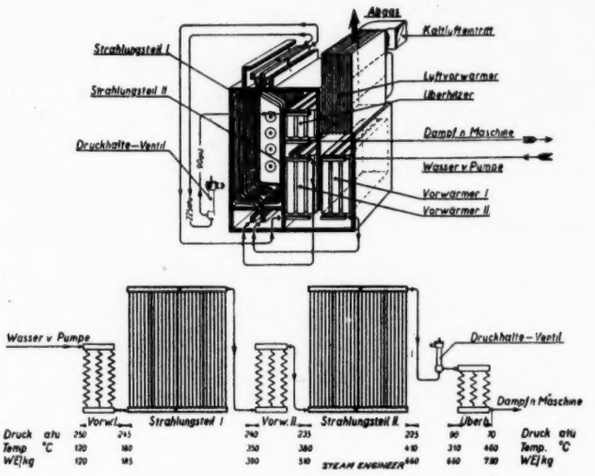


Fig. 5—Layout of Benson boiler on S.S. Uckermark.

The *Uckermark* was put into regular service to the Dutch Indies and is now returning to Hamburg from her seventh round trip. The experiences gained with the Benson boiler on board were extremely satisfactory.

EXPERIENCES

Material

Special qualities were required of the high-pressure tube material. Although in the first two test installations (Rugby and Siemensstadt) good results were obtained with pure carbon steel, which had to be used due to the lack of reasonably priced alloys, it was later preferred to use, at least for the tubes exposed to radiant heat, a 3 to 5 per cent nickel steel. Still later a steel with a certain content of carbon, manganese and molybdenum was preferred and is now in use with good results in almost all Benson boilers.

Pipe Connections

The coils constituting the heating surfaces are manufactured from standard straight tubes by cold bending and welding. Larger pipes, such as main lines between headers, main feed lines, steam mains, etc., from certain diameters upward are connected by means of a sleeve screwed upon the pipe ends and welded.

The number of detachable connections has always been reduced to a minimum. With respect to the unusually high pressure in connection with sudden temperature changes (due to the quick starting and stopping of the Benson boiler), new designs had to be provided for all the flanges, gaskets, bolts and washers. Special reference may be made here to the metal lenses ultimately found as the best solution and to the spring washers necessary to compensate the different changes in length of flange and bolts.

Valves

New designs had also to be developed for all the

valves used in Benson installations. They are all angle valves manufactured from solid blocks of steel and are unbalanced on account of the small dimensions.

Feedwater

In the first experimental plant at Rugby the feedwater problem did not become evident, because pure condensate was used, nor did it seem important in the second test installation at Siemensstadt, where most of the salt contained in the feedwater was deposited in the drum of the low-pressure boiler serving as economizer for the Benson boiler.

The first real experiences relating to feedwater problems were gained in the first cable-works installation, where a high percentage of zeolite-softened make-up water had to be used and the returning condensate was often contaminated by raw water. After it was recognized, however, that with such high concentrations in the feedwater troubles were unavoidable, a closed cycle was insured for the Benson boiler by installing heat exchangers where the exhaust from the turbine is condensed and the low-pressure process steam generated from the highly concentrated feedwater. The make-up water for the closed high-pressure cycle, which is, of course, relatively small, is now supplied by evaporators.

The effect of this measure has proved it to be correct and in all following Benson boiler installations it has been always emphasized that pure feedwater should be available and that its concentration should be continually watched.

This does not mean, however, that the salt concentration may not increase temporarily to much higher values, as is liable to happen in cases of condenser leakage. To investigate this question, an artificial salt-water leak was caused on the steamer *Uckermark* on her fifth home voyage between Amsterdam and Hamburg, in the beginning of this year. The test results show a considerable increase of concentration during 16 hours without any trouble occurring. At the end of the test the salts were washed out completely.

There is another problem, however, which in cases of continuous operation arises even with the lowest feedwater concentrations. This is due to the fact that the salts are deposited always in a definite zone where they accumulate and must be removed from time to time. In most Benson boilers this zone happened to be exposed to heat radiation, thus causing tube failures when the deposits had become too thick. It was therefore decided to change the flow of water and steam so as to insure this zone of deposits being located in the convection part of the heating surface. After these changes were made, the operation of all the boilers has become absolutely satisfactory.

For all of these important measures patents were granted or applied for in most countries.

Feed-pumps

In the first Benson boiler installations plunger feed-pumps were used exclusively. These pumps were on the market for hydraulic purposes in a high grade of development. Only the packing material had to be tried out for the high feedwater

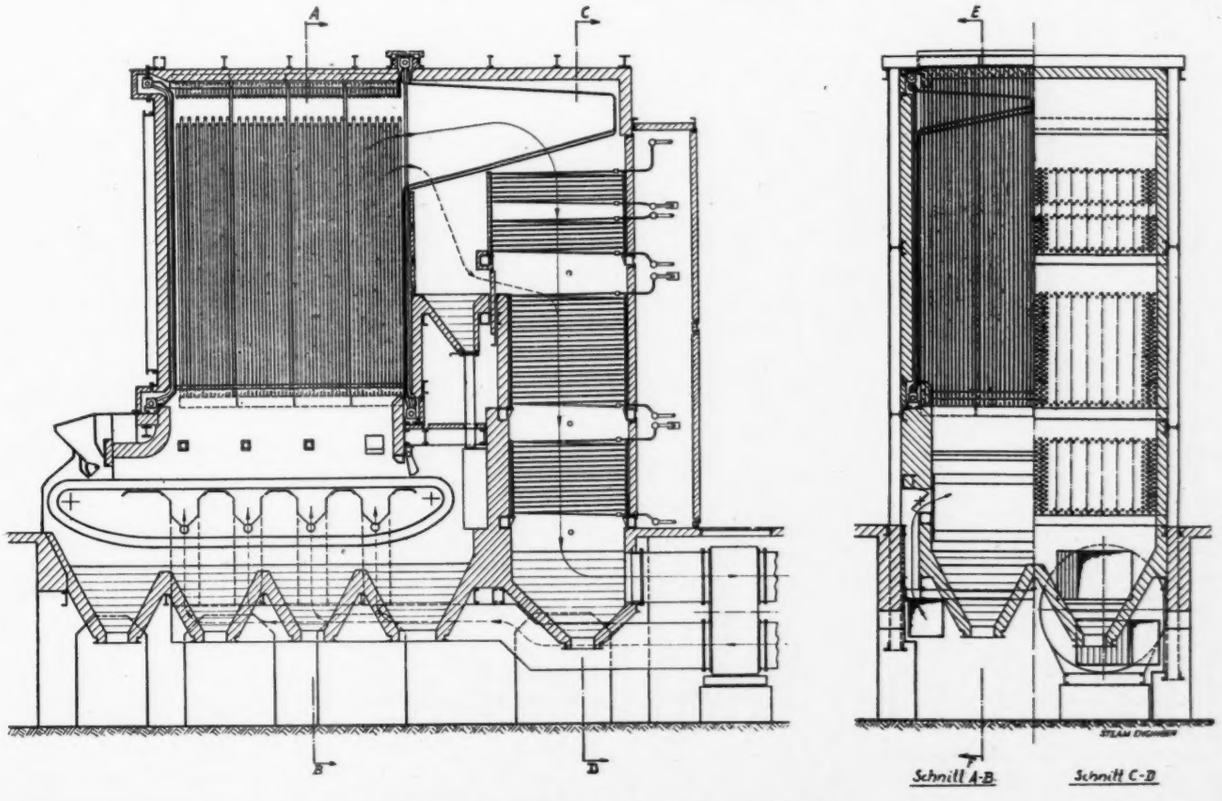


Fig. 6—Benson boiler with chain grate stoker.

temperatures. Today this problem may be considered as solved.

Reciprocating pumps are recommended at present for capacities up to, say, 150,000 lb. per hour. For larger capacities centrifugal pumps are to be preferred. After various makes of centrifugal pumps had been tried in the cable works, two large Sulzer pumps were installed at Langerbrugge, and are working there satisfactorily.

The Benson system has sometimes been reproached in literature for the large amount of work required by the feed-pump, which is approximately 3.5 per cent of the power obtainable from the turbine as compared with 1.5 per cent in the case of a 1400 lb. plant. In comparing these figures, however, one should always bear in mind that the work obtained by the steam expanding from the higher initial pressure exceeds several times the increased work required by the feed-pump.

At Langerbrugge, *e.g.*, the total steam leaving the boiler expands from 2,850 lb. to 750 lb. per sq. in. in a high-pressure turbine, which drives the feed-pump and a generator delivering 2500 kw. at full load.

Boiler Operation, Remote Control

The operation of the Benson boiler is at least as simple as that of any other boiler of modern type; in some respects even simpler. Since the Benson boiler has no drum, there is no water gage to be watched, and it is simply necessary for the operator to see that the flow meter in the feed line shows the desired load. In some cases thermometers have also been installed at the outlets of the individual parallel rows, in order to be certain that all the tubes generated their proper share of steam.

The Benson boilers are generally operated from a central control room, more or less remote from the boiler, where all the instruments and control apparatus are arranged. From there the speeds of the feed-pumps, fans, coal feeders and also the positions of all important valves can be controlled by push buttons or automatically. Pressure and temperature controls are automatic in almost all Benson plants built so far, so that only the load and CO_2 content of the flue gases must be controlled by hand.

The fact that the Benson boiler has practically no water storage capacity and that heat-storing masses were kept as small as possible, makes this boiler a very quick starting unit and extremely flexible in operation. Moreover, the lack of water storage has the effect that possible ruptures prove very harmless so that the operation of the Benson boiler may be regarded as absolutely safe.

The boiler can be run up to the normal load from the cold state within less than ten minutes.

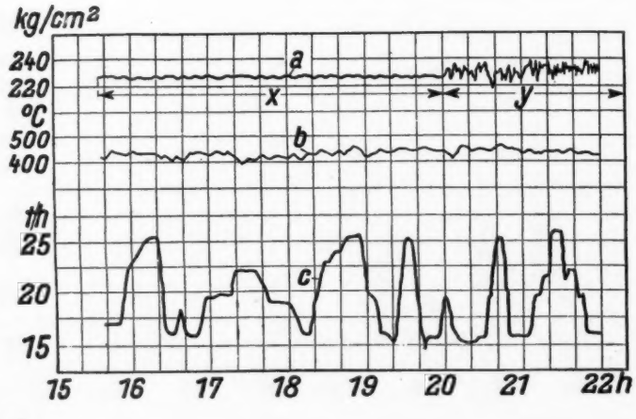
Automatic-Pressure and Temperature Control

As already mentioned, pressure and temperature are in most cases controlled automatically. Although there existed some systems of automatic control when the first Benson boilers were built, a new type of electrically-operated precision regulator was developed by the Siemens-Schuckertwerke on the basis of the special requirement of the Benson boiler. The pressure controller was developed first, and later the same principle was applied to the temperature controller.

The controller consists of a Bourdon-type pressure gage or remote-control temperature indicator with suppressed zero point to insure wide scales. On the axis of the indicating instrument is mounted a contact pointer which may swing freely between two other contacts within a given range, but which, as soon as the deviation has reached the limit given by those latter contacts, closes a circuit and actuates a relay which starts a motor to open or close the regulating valve or to change the speed of the coal feeder screws.

In order to avoid over-regulation, a very ingenious device for insuring a slowly yielding return is provided. The desired normal value, the ± tolerance and the softness of the yielding return may be easily adjusted at any time even when the regulator is in operation. Fig. 7 illustrates the effect of the automatic pressure and temperature regulation as compared with the operation by hand in a case of heavy load changes.

The automatic controllers have not only given very satisfactory results in all Benson boiler installations, but have also proved useful in low-pressure steam plants and in other branches of industry for the regulation of pressures, temperatures and other quantities. The regulators are therefore now being manufactured as a listed product and installed for many purposes.



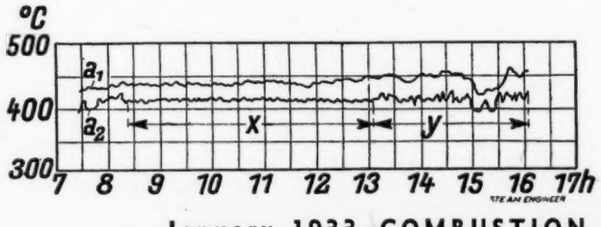


Fig. 7—Automatic Pressure and Temperature Control—Test Results

Pressure Regulation. a—Pressure, Heater Outlet. b—Temperature, Heater Outlet. c—Steam Output. Temperature Regulation. a_1—Temperature, Superheater Outlet. a_2—Temperature, Heater Outlet. x—Operation Automatically. y—Operation by Hand.

Efficiencies

In the first commercial installations in the cable works, efficiencies were measured as high as 84 to 86 per cent, whereas at the test boiler at the Technische Hochschule Charlottenburg 83 to 84 per cent were reached. At the Langerbrugge station there are only average efficiency figures available around 81 per cent. Considering the fact that these efficiencies were gained at highly varying loads and with coal of very high ash content, there is no doubt that under normal load and coal conditions efficiencies of 86 to 87 per cent will be reached. The efficiency of the Benson marine boiler on board s.s. *Uckermark* was measured to be 89 per cent.

Summary

To conclude, the advantages of the Benson boiler may be summed up as follows: The construction of the Benson boiler is very simple, the boiler is light (no drums) and requires little floor space. All pipes are very small in diameter. The thermal efficiency obtainable at the critical pressure is the maximum possible with steam. Because of the forced flow, circulation troubles do not exist. Due to the small water storage the boiler is absolutely safe, can be started quickly and is extremely flexible in operation. Last, but not least, its price is not higher than that of a normal 500-lb. plant of same size.

Great Engineering Gathering At Chicago

What promises to be the greatest and most important conference of engineers ever held in this country, and probably the world, will convene in Chicago during the week of June 25-30 in connection with A Century of Progress Exposition. World's Fair officials have designated this period as "Engineering Week," and one day will be known as "Engineers' Day."

Early estimates of the probable attendance of engineers from all parts of the country, as well as from many European countries, place the figure at a minimum of 25,000 with a possibility of triple that number.

A general committee known as the Engineering Societies Committee of A Century of Progress Exposition has already been established in Chicago under the chairmanship of Harry B. Gear. Organization work is now under way and a number of sub-committees have been appointed to function on the various phases of the coming event.

The plan is for the various societies to hold individual or joint meetings of their own groups except for "Engineers' Day" when all groups will join in a giant conference.

The outstanding engineers of this and other countries will appear on the program to report the newest developments in their respective fields.

Coincident with the speaking program there will be held an exposition of power and engineering machinery and appliances in keeping with the size and importance of the gathering.

Approval of participation has already been given by 19 engineering associations, either by their national headquarters, or through their Chicago chapters. Others will also participate. The organizations cooperating are as follows:

American Association of Engineers
American Ceramics Society
American Foundrymen's Association
American Institute of Electrical Engineers
American Institute of Mining and Metallurgical Engineers
American Society of Civil Engineers
American Society of Mechanical Engineers
American Society of Municipal Engineers
American Society of Testing Materials
American Society of Agricultural Engineers
National Council of State Boards of Engineering Examiners
Society for the Promotion of Engineering Education
Society of Industrial Engineers
Institute of Radio Engineers
Western Society of Engineers
American Institute of Architects
American Society of Heating and Ventilating Engineers
American Society of Refrigerating Engineers
National Association of Practical Refrigerating Engineers

New A. S. T. M. Standards

The American Society for Testing Materials follows the commendable practice of publishing its specifications and test methods prior to their formal adoption as standards. The Society's purpose is to have these standards recognized as not having been adopted merely by their membership but as standards which have been developed by industry itself. The practice of publishing these standards in tentative form and giving them wide publicity prior to their formal adoption permits the consideration of comments and criticisms from many sources, and assures that the standards as finally adopted reflect the best judgment of practically all concerned.

Among the tentative standards accepted at the recent annual meeting of the Society are the following:

Tentative Method of Sampling Coke for Analysis —the methods proposed are presented separately for all determinations except total moisture, and for the determination of total moisture.

Tentative Method of Sampling Coal by Ball-Mill Method.

Tentative Specifications for Lap-Welded and Seamless Steel and Lap-Welded Iron Boiler Tubes —these specifications cover manufacture, chemical properties and tests, physical properties and tests, weights, dimensions and permissible variations, workmanship and finish, marking, inspection and rejection.

Those interested in examining these specifications can obtain copies by writing to the American Society for Testing Materials, 1315 Spruce St., Philadelphia.

Patents*

By GEORGE RAMSEY
NEW YORK
Patent Lawyer
Member A. S. M. E.

This article of the series by Mr. Ramsey deals with the situation where a conclusion is reached between the applicant and the Patent Office; with what may be done to correct or change an allowed application; what are forfeited and abandoned applications, and how an abandoned application may be revived. . . . This installment also discusses threats of infringement based upon a pending application, and the marking of commercial articles with "Patent Applied For" or "Patent Pending".

PART VI

Patent Office Procedure (Continued)

Final Rejection

There comes a time in the prosecution of an application when the prosecution reaches such a point that it should be closed. When this happens, the Examiner gives what is known as a "final rejection". The formalities of the application should be cured before this stage is reached, such as correction of language in the specification and claims, or corrections to the drawings. The applicant has a right to amend as often as the Examiner cites new references, but where the Examiner cites a reference that does not in the attorney's opinion anticipate the claims against which the reference is cited, the attorney usually presents a request for reconsideration and sets forth fully the reasons why the claims are not anticipated by the references cited. Under these conditions, no change has been made in the wording in the claims. If the Examiner is of the opinion that the claims are unpatentable over the reference which he has cited, he may as early as the second action enter a final rejection. Where the applicant amends a claim in substance to distinguish from the reference, then the Examiner should not finally reject and if the amendment has been a substantial one which changes the scope of the claim and distinguishes from the reference, either a new reference should be cited by the Examiner or the claim should be allowed. As long as new references are cited, the prosecution of the case may continue. If new claims are presented by way of amendment, which claims differ in scope from those which have been previously rejected and avoid references previously in the case, the prosecution should not be closed but either the claims should be allowed or a further rejection should be given. It is the present attitude of the Patent Office to hurry cases through and it is not unusual that a final rejection is given on the second or third action, but where an attorney does not understand how the references cited are applied by the Examiner and he requests the Examiner to apply the references, a final rejection should not be given. In other words, a final rejection should not be given until a clearly understood issue is reached between the attorney and the Examiner. A final rejection cannot be given unless the claims have been rejected at least once previously upon the same references and for the same reasons. The mere rewording of a claim, however, does not make it a new and different claim providing the scope and subject-matter remains the same as the previously rejected claim, and the Examiner, under these conditions, may finally reject although the particular claim has not previously been rejected but one of the same scope had been rejected. Most of the divisions of the Patent Office follow the practice of rejecting a case and stating that the applicant may expect the next rejection to be final. In that case, the attorney is warned of what is to be expected unless the case is placed in condition for allowance. When new claims are presented, the applicant has the burden of pointing out how the new claims distinguish from the references in order to avoid a final rejection. A final rejection should not be given by the Patent Office on a second action where the device is complicated and where the attorney is earnestly trying to amend his claims to avoid the art cited.

A final rejection closes the prosecution of the application before the Examiner unless the applicant can show for some reason that the final rejection was premature and was not properly given, but if the final rejection is proper, then the prosecution ends except for such an amendment as will place the case in condition for allowance. For example, if the application contains ten claims and claims 1 to 8 have been amended in such manner as to avoid the art cited, and re-

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consideration is requested of claims 9 and 10, if the Examiner is convinced the art meets claims 9 and 10, he may finally reject these two claims. The applicant then has a right to amend his case by cancelling claims 9 and 10, in which case, the application will be allowed. Occasionally, the Examiner will, after final rejection, consider a new claim drafted in such form as to be clearly allowable. The consideration of new claims, after final rejection, is entirely within the discretion of the Examiner and cannot be insisted upon as a matter of right. The admission of such new claims after final rejection does not reopen the case. Sometimes, if the new claim is informal, such as the misstatement of a phrase, the Examiner will advise the applicant if the claim is rewritten, it will be allowed and the case will be passed to issue. This is not to be interpreted as reopening the case for further prosecution after final rejection.

The applicant does have the right, however, to substitute claims for those which were finally rejected in order to place the subject-matter of the rejected claims in better form for appeal. Such substitute claims should not change the scope or subject-matter of the claims which were finally rejected.

The applicant has the right to appeal from a final rejection, and where some claims have been allowed and others finally rejected, the applicant has the choice of appealing the finally rejected claims, or cancelling these claims to put his case in condition for allowance.

An Allowed Application

Where an applicant has accepted the claims which have been allowed by the Examiner and by amendment has cancelled the rejected claims and corrected formal errors in the specification, the application is allowed by the Examiner and goes to the Issue Division. A "Notice of Allowance" is mailed to the attorney of record. This "Notice of Allowance" is dated and identifies the application by name, serial number, filing date, and title. It also specifies the number of claims in the case which have been allowed, and states that a final fee (now $30.00) plus one dollar for each claim in excess of twenty must be paid not later than six months from the date of the Notice of Allowance. This is a statutory period fixed by law and the Patent Office has no authority or jurisdiction to extend the time of payment of the fee. It is no excuse for a late payment of the fee that the Notice of Allowance was not received by the attorney where the records of the Patent Office are regular and indicate that the application was allowed and the notice was sent out. The final fee will not be accepted from anyone other than the applicant, his assignee, attorney, or a party in interest as shown by the records of the Patent Office. The Patent Office makes up a schedule of dates throughout the year on which the final fees close for a particular issue date, and the patent must issue within a period of three months from the date of the payment of the final fee. In the absence of a request to suspend the issue of the patent, the date relative to the payment of the final fee closes weekly on Thursday and the patent will bear the date of the fourth Tuesday thereafter. That is, the patents on applications where the final fees are paid during the period from Friday of one week to Thursday of the next will all issue on the fourth Tuesday after the Thursday closing date. All patents are granted on Tuesday, even though it may be a holiday.

It occasionally happens that after an application has been allowed, the Examiner, in looking through his files, will find a complete reference for claims which he has passed in the allowed case. It is the province of the Patent Office to grant only valid patents, and it is the duty of the Examiner to reject obviously unpatentable claims. Where an application has been allowed and a reference has been subsequently found before the patent issues, the Examiner will direct the Commissioner's attention to the situation and the Commissioner will usually withdraw the application from issue. This has happened even where the specification was printed and ready to be signed and sealed since the Commissioner has jurisdiction of a case until the patent is finally sealed. Under these circumstances, the application is withdrawn from issue and the prosecution is continued.

It is not unusual for an application for patent, when allowed, to be withdrawn from issue to go into interference with some pending application. Interference procedure will be discussed later.

Where an applicant decides to file foreign applications and the six months' period within which the final fee can be paid has practically expired, the applicant may pay the fee and request that the issue of the patent be suspended, in which case, the Commissioner will usually direct that the issuance of the patent be delayed. The suspension period, however, cannot be longer than three months after the payment of the final fee. Ordinarily, an application will not be withdrawn from issue on any request of the applicant unless refusal to do so will work irreparable injury on the applicant. When the six months' period has expired without the payment of a final fee, the Commissioner has not authority to withdraw the case from issue because it is no longer an allowed application, but is now what is known as a "forfeited application."

Where an applicant dies, the Notice of Allowance is binding upon his heirs, and personal representatives who must pay the fee within the six months' period.

In view of the foregoing, it will be observed that the attorney prosecuting the case should at least carefully review the case when it looks as though it were about to be allowed. For example, if all the claims are allowed in the case but one and the attorney feels that this claim may be cancelled without serious loss and he files an amendment cancelling this claim, he may expect the next Official action to be an allowance of the case. Therefore, in this situation, the entire case should be reviewed to be sure there are no mistakes in the specification, that the amendments to the claims

are in the form intended, and to be sure that the case is exactly as desired in final form as a patent. It occasionally happens, however, that after the Notice of Allowance, the attorney will discover some error either in the specification or claims or may find that an unnecessary limitation has been accidentally or inadvertently added to the claims. Under these conditions, he may avail himself of Rule 78 to present a Petition to the Commissioner to amend the application to correct the errors, eliminate the limitations, or make necessary additions. This Petition is not receivable as a matter of right, but is based upon equity and justice.

Amendments After Allowance

Where an amendment had actually arrived in the Patent Office and had been stamped as received, but the Examiner had sent the case to issue and the Notice of Allowance had been mailed before the amendment reached the Examiner's desk, it was held that the allowance was irregular and that the allowance would be withdrawn and the amendment entered. The various departments of the Patent Office have separate and independent jurisdiction, and when a case passes from one department to another, jurisdiction of the case goes with the application. Therefore, when an application is allowed, it passes from the jurisdiction of the Examiner to the jurisdiction of the Issue Division and the Examiner no longer has any authority in the case except by order of the Commissioner who, of course, has jurisdiction of the entire Patent Office.

When an application is ready for allowance, the Examiner may, without authority from the applicant, correct apparent informalities such as misspelling, duplicate words, etc., and he enters these corrections in the file as an "Examiner's Amendment". A copy of this amendment is sent to the attorney and if the attorney disapproves, he may make a proper amendment to correct the informality.

Amendments after a case is allowed may be made only upon a petition granted by the Commissioner, and then the amendment will only be entered on recommendation and approved by the Primary Examiner. Where the final fee has been paid and the specification has been printed, no amendments will be permitted. Amendments after the case has been allowed may include the addition of claims or a correction to the specification or the drawings, all of which the Examiner must approve. Where an amendment is presented after the case is allowed and the Examiner disapproves, it, the amendment will not be entered in the case. It is not necessary for the Examiner to give detailed reasons for his disapproval.

In other words, when a case is allowed, the prosecution of the case is closed and Rule 78 permitting amendments after allowance is not intended to provide an indirect continuation of prosecution of the application. The acceptance of amendments under Rule 78 rests largely with the discretion of the Examiner and his recommendations as to whether the amendment shall or shall not be admitted will not be overruled by the Commissioner except under very unusual circumstances. Where more than one claim is presented under Rule 78 and the Examiner states that certain of the proposed claims are not patentable, no part of the amendment will be admitted. The proper procedure in this situation is to accept the claims which the Examiner will allow and file a new petition and amendment under Rule 78 including only claims which the Examiner will accept. It is by far the best practice to review the application for each amendment to be sure it is in proper final form, because any proper amendment is likely to result in an allowance. Placing the case in condition for allowance is, of course, the purpose of amending.

Forfeited and Renewed Applications

If the final fee is not paid within the statutory period, the application becomes "forfeited". The law provides that a forfeited application may be "renewed" within one year from the date of the original Notice of Allowance. When an application is renewed, a new filing fee is required the same as in an original case. The specification and drawings of the forfeited application may be used for the renewed application. The renewed application takes the original filing date as its effective date regarding references, public use, etc., but as to formalities, a renewed case stands the same as a new application and the mere fact that claims have once been allowed does not prevent the Examiner from rejecting these claims upon some newly discovered prior art.

A forfeited application may be renewed by the attorney without requiring the signature of the applicant for the reason that the Patent Office accepts the original signature as a compliance with the patent law. A renewal may be made by any person who has an interest in the invention whether as inventor, or assignee, as shown by the records in the Patent Office. Even a licensee has been allowed to renew a forfeited application. In renewing an application, additional claims may be presented and the case will proceed as though there had been no allowance.

A question arises in the law as to whether or not a forfeited application for all purposes shall be considered as continuously pending and being prosecuted. It has been held that a forfeiture for certain purposes is a break in the continuous pendency of an application. Therefore, to be perfectly safe if the applicant feels that he does not desire to rely upon a petition under Rule 78 to amend the case, or that for some reason he desires to further prosecute the application, he may renew the application before the six months' period has expired. He does this by filing a renewal petition and the payment of a new filing fee exactly the same as he would renew a forfeited application. In this situation, the applicant is held to have waived his right to the full six months' statutory period, and the renewal having been made before forfeiture, no question can be raised as to the continuous pendency of the case before the Patent

Office as a live application. Where an application has once been renewed, the final fee must be paid within six months after the date of the second Notice of Allowance. It cannot be forfeited and renewed a second time. An application which has been once renewed and is allowed a second time after renewal, becomes abandoned if the final Government fee is not paid within the six months' period allowed in the second Notice of Allowance.

An application which has been forfeited must be renewed within one year from the date of the original Notice of Allowance, otherwise, the application becomes abandoned and is dead.

The law governing the forfeited applications originated in 1864 evidently for the purpose of permitting those who had lost their patent rights by the Civil War to have some redress. That act was in force for six months only and then was reenacted in slightly different form in 1865 and has continued in the Patent Statutes since that time.

The principal advantage of the renewal feature of the patent statute is that it gives the applicant an opportunity to reconsider his application after it has been allowed. It is human nature to defer serious consideration of matters until they come to a final critical stage, and so it often happens in a prosecution of an application that little serous attention is given the case by the inventor until it is allowed. Then he wakes up to the fact that the claims are not as broad as he would like to have them and here is where the renewal statue come to his aid. There is a tendency, however, on the part of the Patent Office to discourage the practice of increasing the length of pendency of applications in the Patent Office, and renewed applications, while getting an additional lease on life in the Patent Office, are usually brought to a final conclusion at a relatively early date.

Where an application is not renewed within one year, it is dead. There is no remedy in the law and the situation is beyond the jurisdiction of the Patent Office. Where an application was allowed and forfeited a second application was allowed; the final fee was not paid on the second application, but a third application was filed after the six months' period of the second allowance. This application was accepted by the Patent Office, allowed, the fee was paid, and the patent issued. Suit for infringement was filed on the patent and the Court held the patent was void on the ground that the law provided for a filing of a renewed application, but did not provide for the renewal of a renewal.

It has also been held where an application was forfeited and renewed for the deliberate purpose of getting it into interference and holding up a competitor that evidence might be introduced to show that the forfeiture was really evidence of abandonment, in which case, the application has been held to be abandoned.

It has also been held where an application was forfeited and a second inventor came into the field in good faith and obtained a patent while the other case was forfeited that the forfeited case could not be renewed with broad claims intended to cover up the patent. The renewal applicant was held to be estopped to assert broad claims because he had abandoned the broad subject-matter by accepting limited claims and allowing the application to forfeit. This is a special case, of course, and ordinarily the mere forfeiture and renewal does not operate as an estoppel or abandonment.

It sometimes happens that the allowed application may not be in the best form and that to renew the allowed application would be to start over again with all the disabilities or defects included in the original application. Under these conditions a substitute new application may be filed which in effect, is the equivalent of the renewal as to all subject-matter common to the original application. Such a substitute application to obtain the benefits of the renewal statute must be filed within the time when the original forfeited application could have been renewed.

A forfeited application has a peculiar status in the Patent Office in that it is not recognized as a pending case for purposes of interference or for purposes of reference on the question of double patenting, etc. If claims in a subsequent application are rejected on the ground of double patenting with reference to a preceding application by the same inventor, this rejection will be withdrawn if one of the applications has been allowed and forfeited. If the forfeited application is renewed, the rejection will be reinstated or if one of the applications should become a patent, the Patent Office will reject the claims in the renewed application on the ground as being unpatentable over claims already allowed in the patent granted.

Abandoned Applications

An abandoned application is one upon which a patent has not issued but which does not afford grounds for further prosecution of any kind in the Patent Office. Another way to state the matter is that an abandoned application is one which has died without issue. The abandonment of an application may be done deliberately by a statement of the inventor that he abandons the application, providing there is no assignee. If there is an assignee of record, the deliberate abandonment of an application by filing a statement by the inventor to that effect must be acquiesced in by the assignee.

Sometimes, an applicant during the prosecution of the application finds the Patent Office has cited completely anticipatory references and therefore decides that further prosecution of the case is useless. In such a case, his attorney is usually instructed not to respond to the last Office action. Where this is done, no statement is in the file as to deliberate abandonment, but, nevertheless, after the six months' period for response expires, the case is abandoned. Occasionally an application which is in bad form will be rewritten and refiled as a substitute or continuing application. The new application should state it is a continuing application of the original which should be identified by serial number of filing date in the continuing case. After the continuing application has been filed, the

parent application may be permitted to abandon without loss of common subject-matter.

Some years ago, it was the practice of some attorneys to prosecute an application, with reference to the art cited by the Office, until an agreement was reached as to allowable subject-matter. Then, a new application would be filed drawn only to the allowable subject-matter, and usually, the second application would be passed to issue without the citation of prior art in the file. The original case containing all of the prior art having been abandoned would be buried in the archives of the Patent Office. Since the history of an application in the Patent Office usually is considered by the Court in determining the scope of the claims in the patent, some attorneys felt that a clear, clean-cut file wrapper was an advantage. The Patent Office, however, recognizes the fact that the public is entitled to full and complete information in connection with the history of an application in the Patent Office, upon which a patent has been granted. Therefore, the Patent Office has discouraged this practice and requires that the specification of the substituted application must refer to the original application. Then, the original case becomes a part of the complete history of the patent.

The advantage of this old practice is doubtful because during patent litigation, the best prior art on the subject usually shows up in Court. If this prior art has not been found by the Patent Office, the Court is more likely to use its own independent judgment as to the effect of the prior art on the claims of the patent, whereas if the prior art has been cited in the Patent Office, the Court may set this prior art aside on the ground that it has been considered by the Patent Examiner and the patent was granted thereover. Therefore, it appears to be sounder practice to proceed in the usual way and prosecute an application through to final allowance, so that the application will show the complete history of the proceedings in the Patent Office. The original application should not be abandoned and a substitute application filed unless there are substantial defects in the original application.

The matter of an abandoned application which involves the greatest difficulty arises where the abandonment is accidental or involuntary due to lack of a proper response within the statutory period, and the applicant does not want to lose the filing date in the original application. Where an application is accidentally or involuntarily abandoned, the circumstances of the case mean that the difficulty is not discovered until the application is actually abandoned. It is then too late to file any continuation or substitute application which will go back to the filing date of the original.

The patent laws contemplate the possibility of an accidental abandonment and specify that the Commissioner of Patents may revive such an abandoned application if it can be shown to his satisfaction that the delay in making a proper response was unavoidable.

The law on this point is as follows:

"All applications for patents shall be completed and prepared for examination within six months after the filing of the application, and in default thereof, or upon failure of the applicant to prosecute the same within six months after any action therein, of which notice shall have been given to the applicant, they shall be regarded as abandoned by the parties thereto, unless it shall be shown to the satisfaction of the Commissioner of Patents that such delay was unavoidable."

Patents exist only by virtue of the patent laws and a situation which does not come within the patent laws is a hopeless one. It will be observed that the patent statute relative to the revival of abandoned cases does not include the situation where a forfeited application is not renewed within the one year allowed by the law. Therefore, this is the reason why at the end of the forfeiture period such an application is dead and is not an abandoned application which might be revived by the Commissioner.

An application may involuntarily be abandoned under many different circumstances. Where an application is filed incomplete and is not completed within six months, the case becomes abandoned. It has been ruled that the period specified by the statute is six calendar months. Therefore, a rejection mailed by the Patent Office on the last day of August must be responded to at least by the last day of February of the next year otherwise the application is abandoned. It has also been ruled that where the last day falls on Sunday or a holiday, the response may be filed on the next succeeding business day. Since the response period is fixed by statute, the Commissioner of Patents has no authority in any way to extend the period. Where an Examiner gives a very full action or rejection in a complicated case, including several claims, the response to the rejection is supposed to be complete and to answer every point raised by the Examiner. Where the response is incomplete, and is filed near the end of the statutory period for response, it is not unusual for the Patent Office to hold the response incomplete and the application abandoned. In this case, the condition of abandonment is based upon a judicial decision and not a statutory effect, because the response did reach the Patent Office within time, but was held by the Examiner to be insufficient. It is entirely proper under these conditions to request a reconsideration of the Examiner's ruling and it is within the jurisdiction of the Patent Office to grant such a reconsideration and reverse itself on the question of abandonment.

The response to an Office action must actually be in the Patent Office within the six months' period. It is not a sufficient excuse that it was lost in the mails or that it was in the mail and delayed when the statutory period expired. Where an Examiner's action from the Patent Office was wrongly addressed and was returned to the Patent Office and then re-mailed, it has been ruled that the statutory period began with the date of the second mailing and that the case was not aban-

doned where proper response was made within six months from that date.

Where no response from the Patent Office is received in a case over a long period of time, the attorney is supposed to use reasonable diligence and since the Official Gazette each week publishes the condition of business in each division of the Patent Office, if the status of the division shows it has passed the date when the previous amendment was filed, then it is up to the attorney to inquire of the Patent Office as to the status of the application in question. If there has been an action, he should immediately obtain a copy thereof, and if the case is abandoned, the attorney should promptly file a petition to revive. Where a case has been allowed and forfeited and is not renewed within one year from the original date of allowance, such a case is dead and cannot be revived because the forfeiture period is fixed by statute, and the statute permitting revival of abandoned applications has been held not to include forfeited applications on which the year has passed.

The procedure to revive an involuntary or accidentally abandoned application comprises a Petition to the Commissioner supported by affidavits stating the facts which show that the delay was unavoidable. The affidavits must set forth very strong reasons for the delay. Unavoidable delay means something more than mere carelessness or merely an excuse based on pressure of other business or that the applicant was so busily engaged in improving his invention that he forgot to respond to the action. It has been held that the negligence on the part of the attorney, even though the applicant continually inquired as to the status of the case, would not constitute an excuse sufficient to result in revival of the application. Sickness may or may not be considered as a sufficient excuse. The excuse must be of such nature as to cover the entire statutory period and an excuse covering the latter portion of the period only is insufficient. Where accidental or unintentional abandonment occurs, the petition to revive must be filed very promptly after the difficulty is discovered. Delay in filing the petition may be fatal. This petition must be accompanied by a full and complete response to the last Office action. The response is considered by the Examiner and if it places the case in condition for allowance, the Commissioner is more likely to consider favorably the petition to revive.

The revival of an abandoned application is not a simple matter and is not based upon any definite right; it is based entirely upon the sufficiency of the showing made and the discretion of the Commissioner. The Commissioner's discretion in the matter is a judicial function and will not be disturbed by the Courts. Once an abandoned application is revived, the Commissioner has no authority to reverse his opinion in connection therewith. The matter is settled for once and all time, and the prosecution of the application proceeds in the usual manner. The question as to whether or not the discretion or decision of the Commissioner was illfounded in reviving an application will not be considered by the Courts as an attack on the validity of the patent during an infringement suit.

Applications Kept In Secrecy

Inventors often ask attorneys if copies can be obtained of an application filed in the Patent Office by others. They also ask if their application when filed becomes a public document.

It is to be definitely understood that all pending, forfeited, and abandoned applications for patent are retained in secrecy by the Patent Office, and, therefore, no one other than the applicant, his attorney, or an assignee of a definite interest of record in the Patent Office, can obtain copies from the Patent Office unless written authority to inspect the case is given by one of the parties previously specified, or unless for some special reason, the Commissioner of Patents authorizes inspection of the application.

The rule of secrecy is so thoroughly observed that the Patent Office will give no information whatever as to a pending, forfeited, or abandoned application except when authorized to do so by a real party in interest. All assignments of interests in an application and the patent that may issue thereon when recorded in the Patent Office are public documents and in this way, the serial number, filing date, and name of the inventor may be legitimately obtained. The Patent Office, in certain cases, where information as to a pending application is legitimately obtained, may advise whether or not any patent has been issued on a specific application.

Where an ex parte appeal is taken to the Courts, the Court records may be inspected by any interested party. The Courts are not required by law to keep an application involved in the appeal in secrecy. This secrecy rule is a Patent Office rule, not a Court rule.

It is inadvisable for an applicant to threaten a competitor that he had better look out, because there is a pending application which is about to become a patent and that the competitor will be sued as an infringer. Where this type of threat has been made, the Courts have ordered the applicant to give the competitor access to the pending application on the ground that the competitor had a right to know the basis for the threat. In aggravated cases, the Commissioner may set aside the secrecy rule without a Court order. The disclosure of a pending case to an opponent is obviously not desirable and it may be serious. It may result in interferences tying up the application for years. It may result in public use proceedings, or other troublesome and expensive things.

Where an application discloses and claims an invention which is being pirated, the Patent Office, if convinced there is patentable novelty in the application, will usually make the case special in order to enable the applicant to get his patent at an early date so that he may promptly bring suit against the pirate.

Applications become public documents as soon

as the patent is granted and may be inspected by anyone. The application of a patent shows the history of the case in the Patent Office and this is often of great importance to the Court in reaching its conclusions in the infringement suit on the patent.

Patent Applied For—Patent Pending

Inventors frequently ask what protection is afforded by marking their commercial articles "Patent Applied For" or "Patent Pending". Patents exist only under Federal laws. There is no provision in the laws for such marking; therefore, this marking asserts no right which can be enforced. An application pending in the Patent Office does not provide any ground for a suit for infringement. The inventor must wait until the patent has issued.

An application is a petition to Governmental authority to grant a patent upon a definite invention. Obviously, the patent does not exist until it is granted. The application itself is not a grant or a concession by the Government and until the application has become a patent, the applicant has nothing which he can enforce in the Courts against one who is appropriating his invention.

The principal reason for marking an article "Patent Applied For" or "Patent Pending" is to advise the public that an application for patent has been made and that a patent may issue at any time on the particular article so that competitors may be discouraged from investing large sums of money in plants, machinery, advertising, etc., to build up a trade which is liable to be stopped by an infringement suit based on a patent which may issue at some future date.

Two Irish gentlemen met and were discussing patents and inventions:

Mike:—"I have often heard that necessity is the mother of invention, but who do you suppose the father is?"

John:—"I don't know."

Mike:—"Well, I'll tell you. I looked at my wife's vacuum cleaner and there it was. It is none other than our old neighbor down the road 'Pat Pending'."

The General Electric Company announces the appointment of A. M. Snodgrass as production manager of their Pittsfield, Mass., works. Since June 1, 1930, Mr. Snodgrass has been production manager of their West Lynn, Mass., works.

Robert E. Cecil, formerly president of the Air Tight Steel Tank Company, Pittsburgh, Pa., has become associated with the Wm. B. Scaife & Sons Company, Oakmont, Pa., as assistant vice-president in charge of sales. Mr. Cecil is well-known for his activities in connection with the A.S.M.E. Boiler Code Committee of which he is a member.

Recommended Practice for Engineering and Scientific Charts for Lantern Slides

A new standard which will be a boon to those who have had to sit through many hours of lectures and papers illustrated with poor and even illegible lantern slides has just been approved by the American Standards Association in the form of an American Recommended Practice for Engineering and Scientific Charts for Lantern Slides (Z15.1-1932).

The standard, which provides rules for widths of lines, lettering, and symbols designed to assure a maximum of legibility, was developed by a special sub-group of subcommittee four on Engineering and Scientific Graphs, of the Sectional Committee on Standards for Graphic Presentation (Z15), sponsored by the American Society of Mechanical Engineers. Walter A. Shewhart, special engineer, Bell Telephone Laboratories, New York, is chairman of this sub-committee; and Harold F. Dodge, Inspection Engineering Department, Bell Telephone Laboratories, is chairman of the sub-group.

In developing the standard, the sub-group directed its attention chiefly to the most common variety of engineering and scientific charts; namely, line charts which show the relationship between two variable quantities. The purpose of the recommendations is the presentation of the data concerned in a systematic way by means of charts suitable for use as lantern slides when reduced to one-third of their original dimensions. With slight modifications as to line widths, the recommendations usually are also applicable to charts that are prepared for use both as lantern slides and as illustrations for publication.

The new standard gives rules for the essential set-up of the charts; it further specifies types and sizes of lettering, as well as different line widths, and sizes of four symbols commonly used in graphs—an open circle, a solid circle, a triangle, and a square.

New Standards Formulated by American Institute of Electrical Engineers

Publication of the following new standards by the American Institute of Electrical Engineers is announced by the American Standards Association, under whose auspices the standards were formulated:

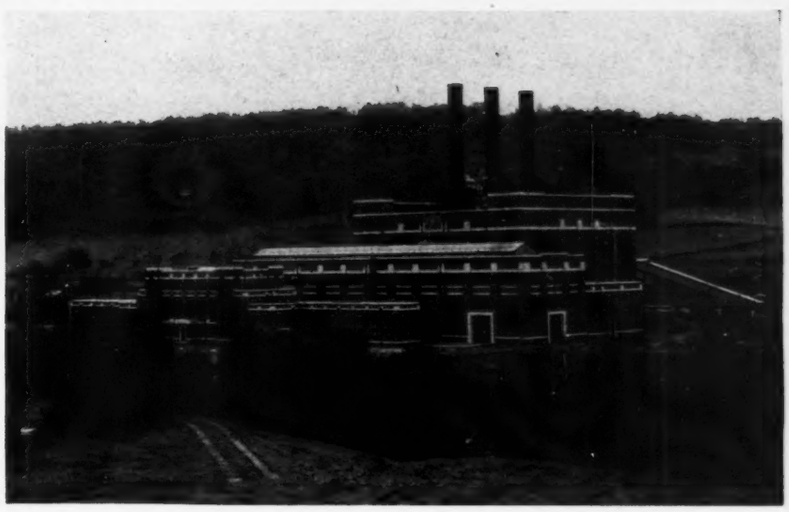
American Tentative Standard for Weatherproof Wires and Cables (C8k1-1932).

American Tentative Standard for Heat-Resisting Wires and Cables (C8k2-1932).

American Standard Definitions and General Standards for Wires and Cables (C8a-1932).

The price of the standards for heat-resisting wires and cables is 20 cents each, and that of the standard definitions and general standards 40 cents.

By DAVID BROWNLIE,
LONDON



Ironbridge Station.

New British Power Stations Equipped for Flue Dust Removal

This article describes the first section of the Ironbridge Power Station, placed in operation in October 1932, which has an elaborate installation for the collection of dust from flue gases. Brief reference is also made to the section of the Battersea Power Station now under construction which will be equipped for washing of the combustion gases. The installation of dust collection equipment at Ironbridge is said to be the first in the world in which the dust collectors are arranged in parallel before the induced draft fans. It is believed that with this arrangement the problem of erosion of fan blades, casings, etc., will be practically eliminated. A dust removal efficiency of 95 per cent is expected.

IT is not necessary to emphasize that one of the main power station problems today is the emission from stacks of smoke, dust, and acid sulphur compounds. Another extremely serious problem is the erosion of induced draft fan blades, casings, and dampers by the sand blast action of the dust in the gases under the present conditions of very high draft requirements.

In this connection there are two stations in England, of great interest,—Ironbridge, near Shrewsbury, of the West Midlands Joint Electricity Authority, and Battersea, of the London Power Co. Ltd.

The latter is designed for 480,000 kw., and the present section of 160,000 kw., now in course of construction, will be the first in England to be fitted with plant to scrub the whole of the combustion gases with water sprays so as to remove the bulk of the acid sulphur compounds, nearly all sulphur dioxide.

Full details cannot yet be obtained concerning Battersea, but the first section will include six boilers, each of 312,000 lb. normal evaporation per hr., to operate at 650 lb. pressure and 875-900 deg. fahr. superheated steam temperature. Each of the boilers will be fired with a multiple retort stoker of 20 retorts into which coal will be fed by sectionally-operated drives, each drive providing for a group of four retorts and each group of retorts being subject to separate control. The total overall width of the stoker will be 34 ft. 11½ in.

These boilers will supply two 80,000 kw. British-Thompson-Houston turbo-generators. The station is designed for an ultimate installation of 18 boilers, 6 of which will be stand-by, and 6 turbo-generators of 80,000 kw. each.

Nothing very definite is known concerning the huge gas washing plant being installed which will use hot water sprays at about 160 deg. fahr. and take, so far as can be ascertained, about 17-22 tons of water per ton of coal burned.

The chief characteristics of Battersea can be summed up as medium steam pressure, very high

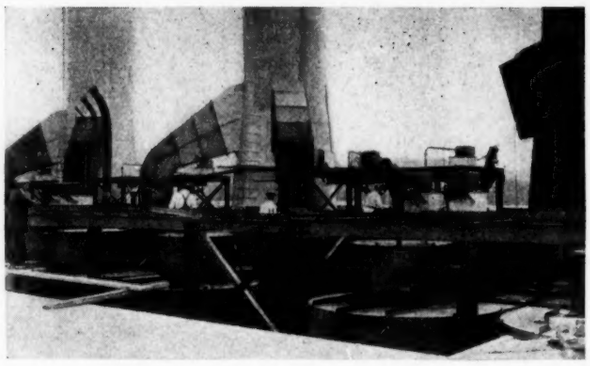
temperature of superheat, large boilers (for Great Britain), multiple retort stokers, complete washing of all the combustion gases, large turbo-generators (for Great Britain) and reheating.

As regards Ironbridge, the first section was officially opened on October 13 last, and is mainly of interest as being the first power station in the world to be completely equipped with dust collectors in parallel on the suction side of the induced draft fans, so that individual collectors can be cut out as desired to give maximum efficiency at different loads.

This general principle of erecting the collectors before the induced draft fans represents a solution of the problem of fan erosion as well as that of dust nuisance from the stacks.

Ironbridge is a base load station designed for 60 per cent load factor, and for an ultimate capacity of 200,000 kw., to be supplied by four 50,000 kw. turbo-generators. The site is at Buildwas, one mile west of Ironbridge, near Shrewsbury, on the River Severn, which at this point has a rise of 24 ft., providing ample cooling water. Incidentally the neighborhood is of great historical interest in the world of engineering.

Near here was the famous Coalbrookdale iron works, still partly in operation, where coke was first successfully used instead of charcoal in the blast furnace, while the name Ironbridge comes from the first bridge in the world made of iron; this is still in use over the Severn. Here also lived John Wilkinson who made the original iron ship,



Construction view of dust collectors at Ironbridge.

then regarded as an almost incredible achievement.

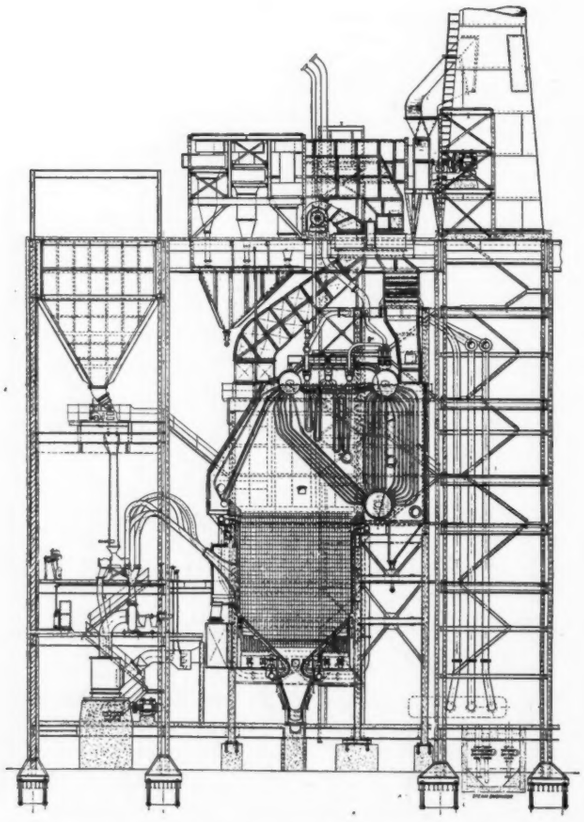
The main plant at Ironbridge, representing the first section, consists of 3 Stirling boilers, 12 Sirocco forced and induced draft fans, with Vulcan-Sinclair couplings, 36 Davidson dust collectors, and a 50,000 kw. British-Thompson-Houston turbo-generator. Also the buildings have been completed for a second 50,000 kw. turbo-generator.

Coal handling equipment has been supplied by the Mitchell Conveyor and Transporter Co. Ltd., London, delivering to stock or to three overhead bunkers in the boiler house, each of 388 tons capacity. The coal comes by rail, and the present stock accommodation is 40,000 tons, to be increased to 70,000 tons.

The three boilers are of the usual Stirling tridrum type, with a total heating surface of 21,600 sq. ft. each giving a normal duty of 225,000 lb. evaporation per hr. with 270,000 lb. overload. Operating conditions are 400 lb. per sq. in. pressure at the stop valve with the safety valve loaded to 445 lb. pressure and 800 deg. fahr. superheated steam temperature. Each boiler is equipped with a Stirling superheater, of 7,750 sq. ft. heating surface, and a Foster steel-tube feedwater economizer of 6,864 sq. ft. heating surface which raises the temperature of the feedwater from 300 to 350 deg. fahr. and reduces the temperature of the combustion gases from 654 to 512 deg. fahr..

Each boiler is also equipped with two Howden-Ljungstrum air heaters having a total heating surface of 32,000 sq. ft. which at normal duty, raise 56,300 cu. ft. of air per min. from 60 to 415 deg. fahr. while reducing the combustion gases from 512 to 260 deg. fahr.

Feedwater supply is controlled by Copes automatic regulators. Each boiler has one pressure regulating valve, 6 in. dia., and beyond this the boiler feed pipe branches to two 4 in. mains, each of which is fitted with an automatic regulator capable of passing 150,000 lb. of water per hr. All the boiler mountings are by Hopkinsons Ltd. and the boiler feed pumps, four in number, are of Weir centrifugal type. Three are direct driven by 310 hp. motors running at 1,490 r.p.m. and each having a maximum duty of 340,000 lb. of water per hr. against a pressure of 500 lb. per sq. in., while the fourth pump is driven by a steam turbine and has a duty of 420,000 lb. of water per hr.



Sectional elevation of one of the Ironbridge boiler units.

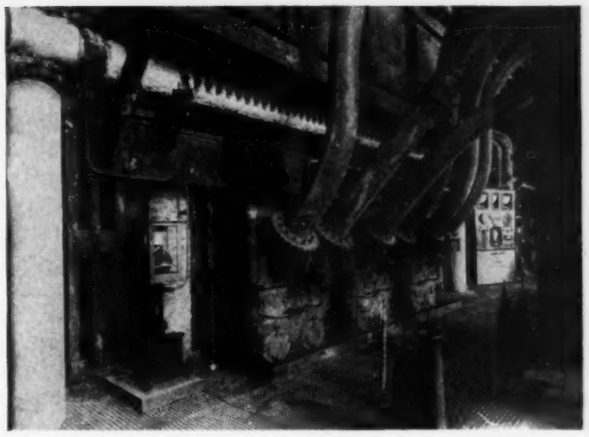
The boilers are fired with pulverized fuel by the direct-firing method, each unit being supplied by three Lehigh ball mills direct driven by 150 hp. Metropolitan-Vickers motors. Each pulverizing mill has a normal duty of 7 tons of coal per hour, which permits two mills to serve a boiler at normal load conditions. Hot air at about 160 deg. fahr. is circulated through the mills by a fan driven by a 50 hp. motor. Each boiler is fired by 6 Calumet burners of 5,650 lb. of dried pulverized coal per hour normal capacity. Auxiliary oil burners are provided for lighting the pulverized fuel.

The boiler combustion chambers, are 24 ft. 0 in. by 21 ft. 0 in. by 50 ft. 6 in. and are equipped with Bailey water-cooled walls of 3,900 sq. ft. heating surface. Heat absorption according to the design figures, is as follows: boiler—6300 B.t.u. per sq. ft., superheater—7200 B.t.u. per sq. ft. and water walls —22,000 B.t.u. per sq. ft.

Each boiler has two single inlet Sirocco induced draft fans, direct driven, through Vulcan-Sinclair infinitely-variable-speed hydraulic couplings, by a 220 hp. Metro-Vick squirrel cake a.c. motor. The constant speed of the latter is 585 r.p.m. per min., and the maximum duty of each fan is 76,500 cu. ft. of combustion gases per minute at 260 deg. fahr. against 8¾ in. w.g. corresponding to 65 per cent of the total gases at normal rating.

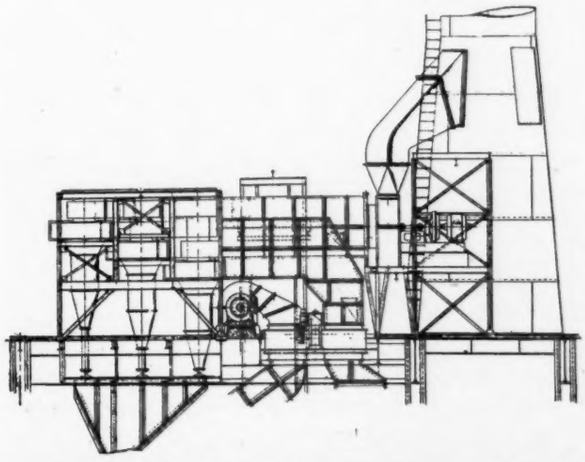
Air is supplied to each boiler furnace by two 35 in. dia. Sirocco double-inlet forced draft fans, capable of handling 41,000 cu. ft. of air per min. at 8 in. w.g., and direct driven by a 110 hp. Metro-Vick a.c. motor running at 965 r.p.m. Vulcan Sinclair couplings provide infinite variation of fan speed.

Each of the induced draft fans has on the suction side 6 Davidson "Type D" dust collectors in parallel, arranged in two rows of three each, with a common dust storage bunker underneath. That is, each boiler has 2 forced draft fans, 2 induced draft fans, and 12 dust collectors. It is found that still higher dust separation efficiency can be obtained with these collectors when using a number of smaller units in parallel as compared with any one or two collectors of larger size, while particularly important as already indicated is that the arrangement allows of any number of the collectors being shut out of the circuit according to the duty of the boilers, thus insuring maximum dust separating efficiency at all loads. Normal performance at Ironbridge is 24 collectors running out of the total of 36, that is 8 per boiler, with 4 per boiler as a stand-by.

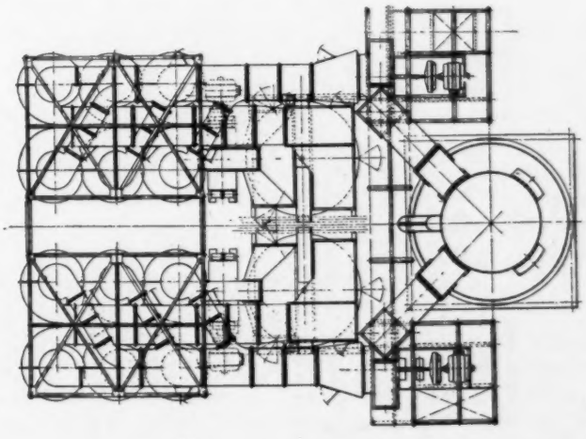


View of pulverized fuel burners for one boiler.

The basic principle of the collectors, now more or less familiar, consists of the use of a large horizontal casing of volute shape through which all the combustion gases pass in such a manner that the dust particles are continuously thrown outwards by centrifugal force and also downwards by gravity, no water sprays being used. This avoids corrosion, cooling of the gases and therefore reduction in natural draft, and the deposition of a dirty rain around the top of the chimneys. Extensive experience, represented by the equipment of over 100 power stations with more than 600 collectors has shown about 90 to 95 per cent of the total dust is separated and that an appreciable proportion is less than 20 microns in size (1 micron equals one thousandth part of a millimeter), an extreme degree of sub-division corresponding to the actual "smoke" stage. At Ironbridge it is calculated that an average of over 95 per cent of the



Elevation showing from left to right dust collectors, forced draft fan, air preheater, induced draft fan and stack.



Plan of view opposite.

total dust (including soot blowing) will be removed.

The ash is handled by Hydrojet equipment being discharged from the furnaces into water quenching cast-iron hoppers lined with firebrick from which it is removed at intervals, traveling through a sealed water sluice into a central sump. From the latter the sludge is taken by three Hydroseal vertical single-stage centrifugal pumps, largely constructed of hard alloy to resist abrasion, and discharged to two large overhead drainage tanks outside the boiler house, each of 3,000 cu. ft. capacity and having hydraulically operated gates at the bottom. Also all the fine dust from the battery of collectors as well as the economizer chambers is removed by a Hydrovac suction system operated by a water ejector and discharged to the same overhead drainage tanks.

The British-Thomson-Houston turbo-generator is a 2-cylinder machine running at 1500 r.p.m. with 4-stage feed heating and reheating of the steam. It has a capacity of 50,000 kw. under conditions of 375 lb. pressure and 750-800 deg. fahr. superheated steam temperature at the stop valve. The H.P. cylinder has 19 stages, and the L.P. cylinder has 8 double-flow stages, while the maximum efficiency is given at 40,000 kw. As regards the condenser this is of the twin Hick-Breguet regenerator type, having a cooling surface of 38,660 sq. ft. Normal duty is 294,570 lb. of steam per hr. giving a vacuum of 29.1 in. mercury with cooling water at 55 deg. fahr.

Essentially the main points of Ironbridge are simple lay-out, relatively low steam pressure, high superheat, large boilers (for Great Britain), unit pulverizers, and treatment of the whole of the combustion gases for dust removal on very advanced lines.

Norman J. Gould, president of Gould's Pumps, Inc., has announced the acquisition of the Hydroil Corporation, of Lebanon, Indiana, manufacturers of oil purifying apparatus.

The Lebanon plant is being discontinued and the business and equipment transferred to the Seneca Falls plant of the Gould company. D. B. Clark, vice president of Hydroil, and W. P. Alexander, factory and field representative, will join the Gould organization, which will continue to manufacture the Hydroil centrifugal purifying machines at Seneca Falls, with production planned to begin January 1, 1933.

James D. Cunningham president of the Republic Flowmeters Company, Chicago, has been made chairman of the Committee on Industrial Rehabilitation. Mr. Cunningham was also elected a vice president of the A.S.M.E. at the annual meeting in December.

Engineers Council for Professional Development Established by Engineering Societies

Seven national engineering bodies have organized the Engineers' Council for Professional Development with the annnounced objective of advancing the professional status of the engineer. The participating bodies and their representatives are:

American Society of Civil Engineers
J. Vipond Davies, Harrison P. Eddy, C. F. Loweth

American Institute of Mining and Metallurgical Engineers
Donald F. Irvin, D. H. McLaughlin, Benjamin F. Tillson

American Society of Mechanical Engineers
C. F. Hirshfeld, J. H. Lawrence, W. E. Wickenden

American Institute of Electrical Engineers
Charles F. Scott, C. O. Bickelhaupt, L. W. W. Morrow

American Institute of Chemical Engineers
H. C. Parmelee, A. B. Newman, John M. Weiss

Society for the Promotion of Engineering Education
Robert I. Rees, H. P. Hammond, Dugald C. Jackson

National Council of State Boards of Engineering Examiners
D. B. Steinman, T. Keith Legare, P. H. Daggett

This new agency plans to coordinate and promote efforts directed toward higher professional standards. Its immediate objective is the development of a system whereby the progress of the young engineer toward professional standing can be recognized by the man himself, by the profession, and by the public through the development of those qualifications which render the engineer a valuable member of society. It is believed that this will involve increased development along social, economic and general cultural lines, as well as the maintenance of high technical standards of education and practice.

The Engineers' Council for Professional Development is embarking on a program of improving means for educational guidance of young men with respect to the engineering profession, the formulation of criteria for colleges of engineering, the determination of a program of personal and professional growth for young engineering graduates, and the formulation of methods whereby engineers who have met suitable standards may receive corresponding professional recognition.

Four committees have been appointed to carry on this program. They are:

The Committee on Student Selection and Guidance with Harrison P. Eddy, Consulting Engineer. Boston, Mass., as Chairman.

The Committee on Engineering Schools with Dr. Karl T. Compton, President, Massachusetts Institute of Technology, as Chairman.

The Committee on Professional Training with Robert I. Rees, Assistant Vice-President, American Telephone and Telegraph Company, as Chairman.

The Committee on Professional Recognition with Conrad N. Lauer, President, Philadelphia Gas Works, as Chairman.

Derivation and Use of Common Formulas Used in Combustion Calculations

PART 3

Calculation of Heat Losses Due to Water Vapor in Products of Combustion

By P. B. PLACE, Engineer

Combustion Engineering Corporation

THE gaseous products of combustion always contain water vapor. This water vapor may come from one or more of the following sources;

1. Moisture in the fuel.
   a. as liquid in solid and liquid fuels.
   b. as vapor in gaseous fuels.
   c. as entrained liquid in gaseous fuels.
2. Hydrogen in the fuel which burns to give nine times its weight of water vapor.
3. Water vapor in the air used for combustion.
4. Water sprays, steam jets or other special sources.

Whatever the source of the water vapor, all of it appears in the waste gases at exit gas temperature, and if the gases are cooled to some temperature below the dew point, all of the water vapor will condense except that amount needed to saturate the gases at that temperature.

Water vapor at exit gas temperatures thus represents a loss, not only of sensible heat but also of latent heat of condensation. This loss is an important item in the heat balance of steam generating equipment.

The difference in the heat content of this water vapor at exit gas temperature and at the temperature of its source is the heat loss chargeable to the fuel.

To calculate this heat loss it is necessary to consider each source separately because all of the water vapor in the gases does not come from the same source and therefore does not represent the same heat loss.

The heat content of the water vapor at the exit gas temperature is the same for all of the water vapor regardless of its source and is dependent only on the temperature of the gases and the partial pressure of the water vapor. The sum of the partial pressures exerted by the dry gases and the water vapor is the total pressure exerted by the wet gases. This pressure may be taken as atmospheric (14.7 lb. per sq. in. abs.) without involving appreciable error. It is necessary to determine the partial pressure of the water vapor in order to establish the condition and heat content of the water vapor, which is really superheated steam at very low pressure.

The partial pressures of constituents of gaseous mixtures are proportional to the per cent by volume of the constituents or to the molal concentration of the constituents. The latter is most easily determined and is found by dividing the weight of dry gases and the weight of total water vapor in pounds per pound of fuel by their respective molecular weights (30 for dry gases and 18 for water vapor) and dividing the number of mols of each by the number of mols of both. The detail of the calculation will be clearly outlined in an example given below.

The above ratios are the ratios of the partial pressures of dry gases and water vapor and the absolute partial pressure of the water vapor is found by multiplying the atmospheric pressure, 14.7 by the water vapor ratio.

To facilitate this calculation, the partial pressures of water vapor are plotted for various weights of dry gases and water vapor, in Fig. 1.

Given the pressure and temperature, the heat content of the water vapor in B.t.u. per lb. is obtained from the steam tables or a total heat diagram. This heat content may be called H.

To determine the heat content of the water vapor when cooled to the temperature of its source, it is necessary to consider each source separately.

1. Moisture in the fuel.
   a. as liquid in solid and liquid fuels.
   b. as vapor in gaseous fuels.
   c. as entrained liquid in gaseous fuels.

Moisture present in the fuel as liquid form (1a and 1c) must be evaporated and therefore its heat of condensation is chargeable as a loss against the fuel. The heat content of such moisture at fuel (source) temperature is therefore the heat of the liquid at this temperature. This heat of the liquid, of moisture in the fuel may be termed h_f. The heat loss due to such moisture is then

$$w\ (H-h_f)$$

where w is the weight of such moisture in pounds per pound of fuel and $(H-h_f)$ is the heat loss in B.t.u. per pound of moisture.

Moisture present in the fuel in vapor form (1 b) is already evaporated and the only heat loss chargeable to the fuel is the loss due to superheating this vapor to exit gas temperature. No latent heat loss for this moisture is involved. Although the heat content of this vapor at fuel temperature may be determined and the difference between it and H

taken as the heat loss, it is much simpler to calculate this sensible heat loss in the usual manner;

B.t.u. loss per pound of moisture =
$$(.47)\ (T-t_f)$$
B.t.u. loss per pound of fuel =
$$(w)\ (.47)\ (T-t_f)$$

where .47 is the mean specific heat of superheated steam, T is the exit gas temperature, t_f is the fuel temperature and w is the weight of such water vapor in pounds per pound of fuel.

2. Hydrogen in the fuel.

All of the hydrogen in the fuel burns to form nine times its weight of water vapor according to the equation;

$$H^2 + 0 = H^2O$$
$$2 + 16 = 18$$
$$1 + 8 = 9$$

If the gases are cooled to fuel temperature, this water vapor will condense and give up its latent heat of condensation. The question is sometimes raised that the hydrogen burns directly to water vapor and therefore the heat of evaporation is not involved. That the heat of evaporation is not involved is immaterial. The heat of condensation *is* involved because the heat of the fuel is determined in a calorimeter under such conditions that this water vapor from hydrogen is condensed. Therefore the heat content of this water vapor at fuel temperature is the heat left in the condensate or the heat of the liquid at fuel temperature. The heat loss due to water vapor from hydrogen is thus;

B.t.u. loss per pound of water vapor = $(H-h_f)$

B.t.u. loss per pound of fuel = $(9\ H^2)\ (H-h_f)$

where H^2 is the weight of hydrogen in the fuel in pounds per pound of fuel.

3. Water vapor in air used for combustion.

This water vapor like the moisture present as vapor in gaseous fuels is already evaporated and does not involve latent heat values. The loss chargeable to the fuel is the superheat and is calculated as follows:

B.t.u. loss per pound of water vapor =
$$(.47)\ (T-t_a)$$
B.t.u. loss per pound of fuel =
$$(w)\ (.47)\ (T-t_a)$$

where T is exit gas temperature, t_a is temperature of the air and w is the weight of water vapor in the air in pounds per pound of fuel.

4. Water sprays, steam jets, etc.

Water from water sprays, ash sluices or water lances must be evaporated and its heat of condensation is therefore chargeable as a loss of fuel heat. The heat content of this source of water vapor is therefore the heat of the liquid at the temperature of the water and the heat loss for such water is

$$(w)\ (H-h)$$

where w is the weight of such water in pounds per pound of fuel, H is the heat content of the superheated vapor in the gases and h is the heat of the liquid at the water temperature.

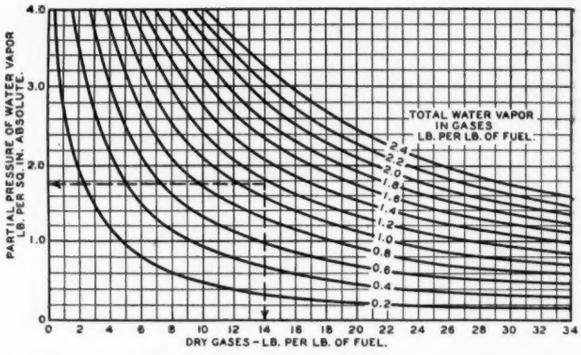

PARTIAL PRESSURE OF WATER VAPOR LB. PER SQ. IN. ABSOLUTE.
TOTAL WATER VAPOR IN GASES LB. PER LB. OF FUEL.
DRY GASES - LB. PER LB. OF FUEL.

Fig. 1—Chart for determining the partial pressure of water vapor in products of combustion.

Water vapor supplied as steam jets, soot blowers, etc. is already evaporated and often superheated to more than exit gas temperatures. The loss or gain from such sources is negligible unless the quantity of steam is very high. The heat involved is the difference between H and the heat content of the steam supply at its temperature and pressure.

For calculating water vapor heat losses involving latent heat, there are two formulas commonly used by combustion engineers:

1. B.t.u. loss = $W\ [1050 + .47\ (T-t)]$
2. B.t.u. loss = $W\ [1090.7 + .455\ T-t]$

in which W is the weight of such water vapor lb. per lb. of fuel, T is exit gas temperature, t is the temperature of the source of the water vapor, .47 is the mean specific heat of superheated steam at atmospheric pressure, .455 is mean specific heat, of superheated steam at partial pressure of 1 or 2 lb., 1050 is the latent heat of evaporation at 75 fahr. and 1090.7 is the total heat of saturated steam at 70 fahr.

The use of the above or similar formulas is complicated by the fact that the water vapor in the gases is not always under the same partial pressure and that the temperature of condensation (dew point) is not constant. As the gases containing a definite amount of superheated steam are cooled, the partial pressure of the superheated steam remains constant until the dew point is reached. At this temperature the steam becomes saturated steam and, if the gases are cooled further, part of the steam condenses, lowering the partial pressure to that of saturated steam at the lower temperature.

Thus the partial pressure, and the condensation temperature vary as the gases cool. The dew point of wet flue gases may be from 110 to 150 fahr. and continuous condensation will occur as the gases are cooled from this dew point down to fuel temperature. It is evident that no one latent heat value can correctly cover all of these conditions.

Actually the error involved in the use of the above formulas is small. Formula No. 1 will tend to give high or low results, for fuel temperatures above or below 75 fahr. Formula No. 2 will give very accurate results and is the formula accepted by the A. S. M. E. Boiler Test Code.

The complete calculations for an assumed case are given below to illustrate the method just described and to compare the results obtained by all three methods.

Water vapor in gases

Source	Condition*	Temperature	Lb. per lb. fuel	B.t.u. per lb.
Moisture in fuel.....	Liquid	60 F.	0.06	28.1
Hydrogen in fuel.....	Liquid	60 F.	0.45	28.1
Moisture in air.....	Vapor	90 F.	0.12	...
Saturated steam jets.....	Vapor	165 lb.-366° F.	0.20	1195.0
Water sprays.....	Liquid	60 F.	0.30	28.1
		Total....	1.13	

* When cooled to source temperature.

Waste gases

	Weight, lb. per lb. fuel = 14.0 Molecular weight dry gases	
CO_2—per cent by volume— 14.5		
O_2—per cent by volume— 4.5	.145 × 44 =	6.38
N_2—per cent by volume— 81.0	.045 × 32 =	1.44
Temperature—°F. 380	.810 × 28 =	22.68
		30.50

Molal concentration of dry gases and water vapor

$$\text{Mols dry gases per lb. fuel} = \frac{14.0}{30.5} = 0.459$$

$$\text{Mols water vapor per lb. fuel} = \frac{1.13}{18} = 0.063$$

Total = 0.522

$$\text{Molal concentration dry gases} = \frac{0.459}{0.522} = 88.0 \text{ per cent}$$

$$\text{Molal concentration of water vapor} = \frac{0.063}{0.522} = 12.0 \text{ per cent}$$

Partial pressure of water vapor in gases

Partial pressure of water vapor—lb. per sq. in. abs. = 14.7 × .12 = 1.76

Total heat in superheated steam in gases

At 1.76 lb. abs. and 380 fahr. = 1231.4 B.t.u. per lb.

Heat losses—B.t.u. per lb. of fuel

Moisture in fuel.....	= 0.06 (1231.5 — 28.1)	= 72.2
Hydrogen in fuel.....	= 0.45 (1231.5 — 28.1)	= 541.5
Water sprays	= 0.30 (1231.5 — 28.1)	= 361.0
Saturated steam jets.....	= 0.20 (1231.5 — 1195.0)	= 7.3
Moisture in air.....	= 0.12 (0.47 (380 — 90))	= 16.4
Total 1.13		998.4 B.t.u.

Heat losses—B.t.u. per lb. of fuel (by Formula No. 1)

Moisture in fuel.....	= 0.06 (1050 + .47 (380 — 60))	= 72.0
Hydrogen in fuel.....	= 0.45 (1050 + .47 (380 — 60))	= 540.0
Water sprays	= 0.30 (1050 + .47 (380 — 60))	= 360.0
Saturated steam jets.....	= 0.20 (.47 (390 — 306)*)	= 7.0
Moisture in air	= 0.12 (.47 (380 — 90)*)	= 16.4
		995.4

Heat losses—B.t.u. per lb. of fuel (by Formula No. 2)

Moisture in fuel.....	= 0.06 (1090.7 + .455 (380 — 60))	= 72.2
Hydrogen in fuel.....	= 0.45 (1090.7 + .455 (380 — 60))	= 541.6
Water sprays	= 0.30 (1090.7 + .455 (380 — 60))	= 361.1
Saturated steam jets..	= 0.20 (.47 (380 — 306)*)	= 7.0
Moisture in air.....	= 0.12 (.47 (380 — 90))	= 16.4
		998.3

* Steam at 165 lb. and 366 deg. fahr. after expanding to atmospheric pressure enters the furnace at 306 deg. fahr.

The Elliott Co., Pittsburgh, Pa., and associated companies, The Lagonda Mfg. Co. and Liberty Mfg. Co. announce the removal of their Baltimore district office to Washington, D. C.

The Henry Vogt Machine Co., Louisville, Ky., has appointed J. R. Fortune & Son, Detroit, district representative for Vogt equipment.

National Industrial Standardization Work at Peak Activity

Bancroft Gherardi, vice president of the American Telephone and Telegraph Company, stated in his address as retiring president of the American Standard Association at the Association's annual meeting at the Hotel Astor that more organizations and more individuals are now engaged in the establishment of national technical standards for the mechanical, electrical, automotive, mining, and other American industries than at any other time since the beginning of national industrial standardization work in 1918.

Despite the depression and drastically reduced funds available for the work, 2700 scientists, engineers, industrialists, and government experts representing 570 technical, trade, and governmental bodies have been at work during 1932 on basic industrial standards, ranging all the way from the sizes of bolts and nuts and screws to the methods of handling explosives in coal mines, and from specifications for insulated wires to standards for the technical operations of the motion picture industry.

During the past year, 43 new national standards have been approved by the American Standards Association, and 32 new national standardization projects have been initiated.

"One of the notable achievements of our work," Mr. Gherardi declared, "has been the development of a form of cooperation between industry and the government which has been extremely successful in practice and satisfactory to both industry and the government. Under the auspices of the American Standards Association, the government departments have been represented on technical committees in charge of standardization projects on an equal basis with all the other groups concerned, including producers, distributors, and consumers. By this arrangement it has been possible to take advantage of the technical skill available in many divisions of the government, while industry maintained an essential control over its own operations."

J. M. Barry, heretofore vice-president in charge of operation for the Alabama Power Co., Birmingham, Ala., recently succeeded to the office of vice-president and general manager. Mr. Barry has been with the company since 1923.

The General Electric Company has appointed William J. O'Meara engineer of their Baltimore office. Entering the employ of the General Electric Company in 1919 on the test course at the Schenectady works, Mr. O'Meara became a student engineer there in 1923. Later in the same year he went to Philadelphia as construction foreman on outside construction work, and in 1930 was made office engineer in the Engineering Department at Philadelphia.

Turbine-Generators —1932 Developments

Editorial Note: Some of the outstanding steam turbine-generator installations by General Electric Company in 1932 are briefly described in the following article which also touches upon recent velopments in steam turbine design and manufacture and upon the mercury-vapor process.

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A second 160,000-kw. 1800-r.p.m. tandem-compound turbine-generator was placed in service in the Hudson Avenue Station of the Brooklyn Edison Company. It is a duplicate of the unit installed last year. During the year heat-rate tests were made which show that both machines are about 0.6 per cent better than guaranteed.

Factory tests were completed on a 150,000-kw. 1800-r.p.m. triple-tandem-compound turbine driving a single generator for the Chicago District Electric Generating Corporation. This unit operates with steam conditions of 1200 lb. steam pressure and 825 deg. total temperature. Between the high- and intermediate-pressure elements the steam is reheated to 825 deg. total tmprature.

A fourth 52,500-kw. tandem-compound 1500-r.p.m. turbine-generator was shipped to CHADE at Buenos Aires. The steam conditions are 550 lb. gage, 750 deg. total temperature, and 1.2 in. back pressure.

Work was begun on a 35,000-kw. 1800-r.p.m. unit for the Buzzard Point Station of the Potomac Electric Power Company. It will be built for a steam pressure of 650 lb. gage, and, owing to the high total temperature of 825 deg. no reheat is required.

A 15,000-kw. condensing turbine-generator was furnished to the City of Richmond (Ind.) which represents an increase in the size of single-cylinder 3600-r.p.m. machines from a previous maximum of 12,500 kw.

Condensing turbines of 25,000 kw., 80 per cent power-factor, 3600 r.p.m., are now under construction.

A complete set of instruments for observing and recording the operation of a turbine-generator was developed and installed on a 160,000-kw. unit. Modern turbines are so large and important that it is desirable to supplement the personal element in judging the operation of the unit with instruments that give both a remote indication and a permanent record of turbine performance.

Among the instruments are an electric eccentricity recorder, an expansion recorder, an interference recorder for rotating parts that will indicate and record a squeak or other sound, a vibration amplifying recorder with detectors on each bearing, and Selsyn power amplifiers for the remote operation and indication of valves.

Welded construction is being used for certain stationary parts of steam turbines and mercury turbines and extensively in the manufacture of the equipment for the Emmet Mercury Vapor Process The use of x-ray inspection resulted in the development of an almost perfect welding technique which renders welded construction available for use in almost any type of service.

Tests on the efficiency of new nozzle and bucket designs were carried on throughout the year, as only by such means is it possible to continue making improvements in the future.

Various high-temperature materials for turbine construction are being tested and the amount of this testing is increasing. These tests are being conducted not only with a view to determining the characteristics and behavior of the various materials, but also with the direct object of determining the behavior under controlled conditions that approximate the conditions of service in a turbine. On account of the very small distortions allowable in turbine construction and the very low stress values used, accurate check tests are required on all materials proposed for turbine construction.

Emmet Mercury-Vapor Process

Changes were completed during March of last year on the 10,000-kw. mercury installation at Hartford, Conn. The furnace now burns oil instead of powdered coal, and steam is generated in the condenser boilers at the design pressure of 425 lb. gage, which is suitable for use in the high-pressure steam section of the station.

The unit has operated practically continuously since starting up in March, and for the five months from June first to November first, when sufficient load was available to load fully the mercury turbine, a total of 73,330,000 kw-hr. were generated at a fuel rate of under 10,000 B.t.u. per kw-hr. sent out. The load factor for the five months was 87 per cent and the use factor 96 per cent.

The installation of the two 20,000-kw. mercury-vapor power-plant equipments referred to in last year's review was nearing completion at the close of the year, one at the Kearny Station of the Public Service Electric and Gas Company, Newark, N. J., the other in the new outdoor power station at the Schenectady Works of the General Electric Company. This plant, using a mercury boiler and turbine, is unusual in several respects. It will be the first out-door steam-electric generating plant. It represents the first instance of coordination by a utility and an industry for their power and steam requirements, depending on the use of a mercury boiler and turbine. The electric output of the power plant will be fed into the commercial system of the New York Power and Light Corp., while the steam output will be used in the Schenectady plant of the General Electric Company.

The principal outdoor feature is a special lagging that covers the turbine casing and bearing brackets as well as the collector rings and exciter. The bearings are equipped with sight-flow indicators located under windows in this lagging. The valve gear parts are all of noncorrodible material to withstand the effects of the weather.

EMPLOYMENT SERVICE

This page is contributed by COMBUSTION for the benefit of unemployed engineers who are qualified to assume responsibility for the design, construction or operation of steam power plants.

There are many plants today which could save thousands of dollars annually by taking advantage of the opportunity which present conditions afford to secure the services of highly trained and experienced men at moderate salaries. Some of the engineers listed on this page have been employed by the largest engineering firms in the country in important positions and at salaries commensurate with their abilities. As soon as business conditions improve the services of these men will be in demand and will not be available at any such salaries as they are now willing to accept.

COMBUSTION hopes it will have the privilege of bringing these engineers into contact with those who can profitably employ them.

A-10. *Education:* Mechanical Engineering, night school and home study. *Experience:* From 1924 to 1930 with consulting engineering firm in charge of design and installation of steam plant equipment for various utility and industrial power plants including one of the largest utility plants in the country. Also made numerous engineering surveys for many types of industrial plants. Since 1930 with paper company in complete charge of design and construction of power plant comprising three high-pressure boilers, ten waste heat and one bark burning boiler, three turbo-generators. Also had supervision of power production at five other plants operated by this company.

A-11. *Education:* Mechanical Engineering. Cornell. *Experience:* 5 years as general plant engineer in charge of a large boiler plant. 12 years with one of the largest manufacturers of mechanical stokers, first as manager of testing and service work and subsequently as engineer in charge of stoker design. 2½ years as consulting engineer to a well known manufacturer of furnace arches, air-cooled walls and similar constructions. Has had wide experience in the design, construction and operation of steam boiler plants and can qualify as an expert on stokers. Has also had considerable experience in technical publicity work having lectured on stokers, produced catalogs, written many technical articles and served as technical editor of a magazine devoted to steam plants.

A-12. *Education:* Mechanical Engineering, Carnegie Institute of Technology. *Experience:* Student engineer with utility company. 4 years in service and erection department of large combustion equipment manufacturer erecting and operating chain grate and underfeed stokers and both direct and storage type pulverized coal equipment. 4 years as power engineer in advisory capacity with paper manufacturer; in this position had experience with both stoker and pulverized-coal-fired boiler plants, extraction-condensing and extraction back-pressure type units as well as burning wood refuse.

A-13. *Education:* Electrical and Mechanical Engineering, various schools. *Experience:* Since 1906 engaged in power plant operation, construction and related activities. Since 1924 has been with large utility management company in a responsible engineering capacity. In this position duties involved the construction, operation, training operating personnel and making special plant studies, surveys, etc., in connection with more than 20 plants of all types and sizes, a number of them outside the U. S. Has also served as a consultant on power plant work for various industrial plants.

A-14. *Education:* General Engineering Courses, Royal Technical College Glasgow. *Experience:* Prior to 1921, marine work, design, manufacture and operation of marine boilers, engines and auxiliaries. In 1921 was placed in charge of the proposal and estimating department for a large British manufacturer of water tube boilers and power equipment. From 1925 until recently has been identified with American consulting engineering firms as mechanical engineer engaged in making preliminary studies, estimates and in designing power plants and executing power plant contracts, particularly with respect to combustion, steam generating. turbine and axiliary equipment; also initial operating and testing. Recent work includes such responsibilities in connection with 4 of the most modern utility plants now in operation, two of which are 1200-lb. pressure plants.

A-15. *Education:* Electrical Engineering, Union College. *Experience:* Since 1916 has been identified with a number of large utility, consulting engineering and management firms. Has specialized in the electrical end of power plant work but has also had experience with steam plant and turbine equipment. Has had full responsibility for design and installation of a number of plants. Has had considerable experience in making special engineering studies, economic surveys, etc., of plant properties.

A-16. *Education:* Mechanical Engineering, Polytechnic Institute. *Experience:* For some years prior to completion of technical education was assistant superintendent of construction for an engineering firm and subsequently for a large electric railway company. Since 1919 has held responsible engineering positions successively in two of the largest consulting and management companies in the country specializing in power plant design and construction.

A-17. *Education:* General scientific and engineering courses, St. Johnsbury Academy. *Experience:* Since 1919 has been identified with various consulting engineering firms specializing in power plant design and construction. Has also had considerable experience in connection with sugar plants and sintering process plants. Has made investigations and studies of combustion and related steam plant equipment.

A-18. *Education:* General and Engineering, Princeton University. *Experience:* 5 years in engineering department of railroad company specializing in shop and power plant—equipment, construction and operation. 5 years with heating equipment company specializing in service work, sales, design and test of all types of heating apparatus. 8 years in independent practice as consulting engineer specializing in design of mechanical equipment building, industrial power plants, etc.

A-19. *Education:* Chemical Engineering, University of Delaware. Postgraduate course, Massachusetts Institute on Technology. *Experience:* Since 1921 has been identified successively with the two largest companies engaged in the manufacture of boilers and related equipment. Has had shop, drafting, testing and field experience, and has been in charge of erection, placing in operation and testing work on a number of power plant installations including some of the largest jobs installed in recent years. Has also had experience as research and analytical chemist on water, coal, iron, steel and micro-photographic analysis.

Note: **Space limitations make it impossible to present adequately the detailed experience and qualifications of the above applicants. The fact that many of them have had similar experience will make it difficult for those interested in their services to make a selection. Consequently, COMBUSTION will be glad to assist inquirers from the detailed information in its files by making recommendations as to applicants who are best qualified for particular positions, or will give the inquirer more detailed information concerning particular applicants. Where inquiry is made concerning certain applicants, as identified by number, such applicants will be asked to communicate directly with the inquirer unless otherwise requested. All inquiries should be addressed to COMBUSTION, Attention of Editor, 200 Madison Avenue, New York.**

NEW EQUIPMENT

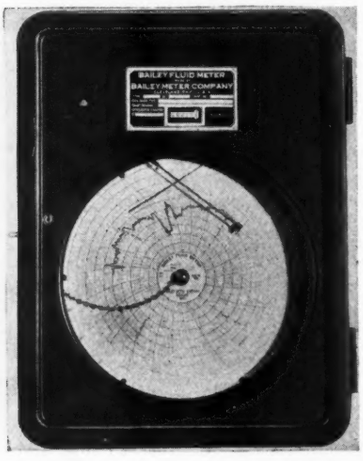
of interest to steam plant Engineers

New Line of Fluid Meters

The manufacture of a new line of fluid meters for the measurement of steam, water, gases, and other fluids has been announced by the Bailey Meter Company, Cleveland, Ohio.

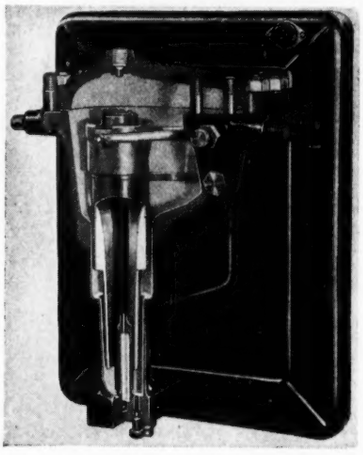
Three general combinations of meters are available: indicating and integrating; recording and integrating; indicating, recording, and integrating. The illustration below shows the recording and integrating fluid meter, which is best suited to the majority of installations. The record is made in pounds per gallons per minute or any other desired units on a 12 in. dia., 24-hour chart. The total flow is given in pounds, gallons or other units by a 6-unit counter which is located behind a small window in the meter name plate. This may be read as easily as an automobile mileage register.

The flow mechanism shown in the illustration at the right is operated by the difference in pressure produced between the inlet side and the outlet side of the orifice or other primary element inserted in the pipe line. The inlet, or higher pressure, is connected to the interior of the mercury sealed Ledoux Bell, and the outlet or lower pressure is applied to the exterior of the bell. The bell responds to changes in the differential pressure, and moves up or down as a frictionless piston; it being shaped so that its vertical movement is directly proportional to the change in the rate of flow. Guide links direct the bell in a definite path which is of particular advantage when the meter is used for marine service or as portable equipment. By means of a forked lever and spindle, motion of the Ledoux Bell



is transmitted directly to the recording pen and integrator.

The new fluid meters are claimed to have a number of features which are particularly desirable. Permanent calibration is assured since adequate protection against sudden surges or reversals of flow is provided. The cases have been arranged to permit mounting either on the surface of a wall or panel, or flush on a panel as desired. Auxiliary recorders, such as for temperature, pressure, vacuum or draft may be easily installed in the case to give a record of



these factors on the same chart with the rate of flow.

The pressed steel case is moisture and dust proof. There are no moving parts which require oiling or greasing. Use of a Warren Synchronous Motor for driving the integrator and chart eliminates the necessity of winding a clock. Each part is made of material most suitable for the service, therefore many special metals are employed such as specially heat treated aluminum, monel, magnesium, cadmium plated brass, tungsten carbide, KA2 Enduro, and stainless steel.

Gun-Pakt

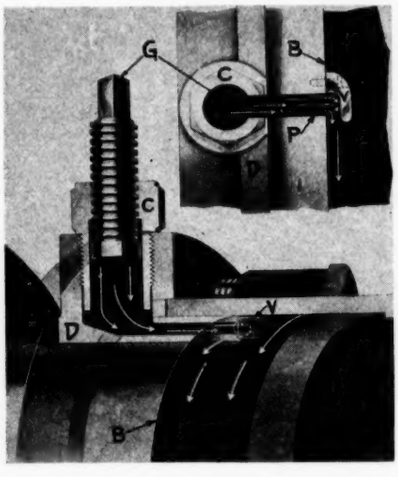
Yarnall-Waring Co. has developed a new method of applying packing which does not necessitate turning off steam from the expansion joint in the line being packed, but can be accomplished through the ingenious application of plastic packing, as described below.

Yarnall-Waring Co. has applied the same principle used in pressure lubrication as a means of packing or replenishing the packing in their Yarway Cylinder Guided Expansion Joint. This is accomplished by merely tightening screw-pressure guns G in cylinder C built into the packing gland D, shown in the accompanying illustration. These guns G force a semi-solid fibrous packing P into the stuffing box B. Hence this gland may be repacked from the outside with ease and convenience, while the equipment is under normal operating steam pressure.

The new cast steel Yarway Gun-Pakt gland is similar to glands using commercial coil packing, except that the Gun-Pakt gland is stationary, being bolted securely against the end of shell of expansion joint. Means for the application of plastic packing have been provided by the use of two or more cylinder units (depending on diameter of gland) the one shown having four cylinders for each gland. These fittings comprise a threaded stainless steel plunger G which operates inside a heavy cylinder C, seated in the rim of the gland, as shown in the accompanying illustration. Yarway plastic packing material—developed especially for the requirements of the Gun-Pakt gland—is made of the highest grade Long Fibre Asbestos, combined with an inert material in which high fire-test mineral oil is stored. This packing is prepared in pellets, shaped to fit the cylinder.

When the plunger G is screwed down, the packing P is forced into the stuffing box B through a channel in the body of the gland. Here an overhanging deflector vane V distributes the packing. Because of these deflector vanes each piston and cylinder makes the packing move around the gland space in the same clockwise direction, thus insuring uniform density of packing in the gland. When necessary to recharge, each Gun-Pakt cylinder fitting can be removed from the gland while under regular line pressure, without disturbing the action of the gland. This is possible because the deflector vanes which act as check valves, prevent blowback. Recharging involves merely insertion of a new pellet of packing. Hence gland may be repacked without removal of either the gland or the old packing. Alemite grease fittings are provided in the body of the joint in the packing space to provide lubrication for the moving sleeve—especially after long shut-downs.

The Yarway Gun-Pakt system and packing are applicable to equipment operating under pressures ranging from sub-atmospheric to the highest pressures and temperatures used in modern steam-heating practice.



New Heat Reflecting Fire Brick

A new type of brick designed for direct exposure and heat reflection has recently been placed on the market by the Armstrong Cork & Insulation Company. This new brick allows quick heating and eliminates heat storage. It is especially suitable for electric furnaces or any type of furnace construction where abrasion from the movement of ware or impingement of gaseous or oil fuel is not a major factor. It is adaptable for flat arch construction, provides extreme strength for

hanging electric elements in the wall, and withstands the quick heating and cooling without spalling. It is claimed that EF Brick, has a great capacity for heat reflection and hence enables equipment that ordinarily takes seven or eight hours to come to temperature, to be brought up within an hour with resultant savings in production, time, and fuel costs.

Another advantage claimed for the new type of brick is that the thinner wall made possible by its use, brings about a worthwhile saving in space and an increase in production capacity.

Armstrong's EF Brick, like the other insulating brick products manufactured by the company, is machine sized. The new brick is made in standard refractory sizes and shapes and can be made in special large sizes and special shapes.

Armstrong's EF Brick is burned at 2100 deg. fahr. and can be used where temperatures will reach this point. It is especially suitable for use where an inner plastic refractory such as Sillimanite is to be put in place.

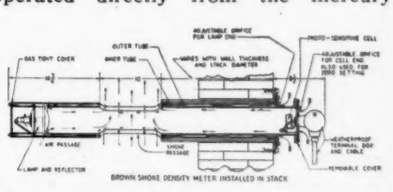
Smoke Density Meter

The Brown Instrument Company has developed a smoke density meter that is claimed to be easy to install and operate, and which requires a minimum of attention. It is a device for measuring the density of smoke in flue gases by electro-optical means. In this type of smoke meter, a portion of the flue gas is made to pass between a source of light and a light-sensitive device. When the smoke in the flue gas varies in density, the amount of light falling upon the light-sensitive device also varies, and the resulting current variation from the photo-cell is transmitted to the indicating or recording meter. Since there is a definite relation between the current output of the photo-cell and the amount of light falling upon it, the meter may be calibrated in terms of smoke density.

The chart of the recording instrument is calibrated to read in per cent smoke density. The indicating scale may read in per cent or in terms of Ringelmann smoke scales.

The preferred instrument arrangement shown below shows a recording meter with signal lamps. The chart record may be valuable for future reference in case of disputes, and the signal lights are a guide for the fireman. By maintaining the correct stack conditions, he not only avoids excessive smoke, but prevents heat loss from excessive dilution of the flue gases. The smoke meter can become a practical guide in the improvement of firing technique, as well as to give warning of impending trouble with the local smoke inspector.

The potentiometer recorder is suggested because the signal lamps can be operated directly from the mercury



BROWN SMOKE DENSITY METER INSTALLED IN STACK

switches in the instrument, without requiring relays or accessory equipment. In addition to the signal lamps, or in place of them, the instrument can be arranged to operate a bell, or other alarm device, whenever the smoke reaches the limit permitted by local regulations.

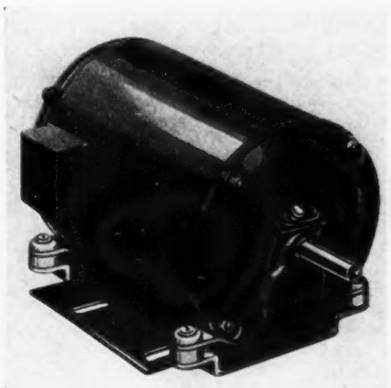
The principal units of the Brown Smoke Density equipment are the sampling tube containing a source of light and a photo-cell, the control panel, and an indicating or recording instrument.

A novel feature of the equipment consists in having the source of light inside the flue, so that only one opening is required in the stack or uptake. This arrangement requires only a small space and greatly simplifies the installation. Another feature is the sampling tube construction which prevents the accumulation of soot or smoke on the lamp or on the light-sensitive device.

Capacitor Motors

The Howell Electric Motors Company, Howell, Michigan, has developed and placed on the market a new fractional horsepower motor which is claimed to have eliminated the objection against previously offered capacitor motors, namely the capacitor box appearing on the outside. The new Howell capacitor motor has a built-in capacitor which gives it the appearance of a conventional motor.

Howell type CI motors are furnished either with waste-packed sleeve or double sealed ball bearings. For sleeve bearings a large oil reservoir is provided with an



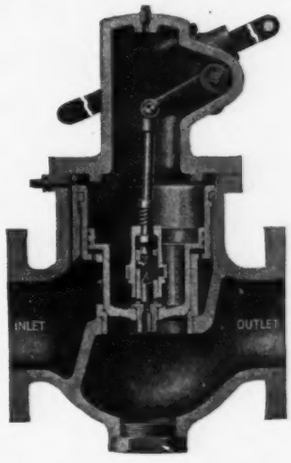
abundance of wool yarn to hold enough to last for long periods, without re-oiling.

This type of Howell CI motor is claimed to be specially applicable to compressors, oil burners, stokers, pumps, etc.

Pilot Controlled Regulating Valve

The Cochrane Corporation, Philadelphia, Pennsylvania, have recently placed on the market a new type of pilot-controlled regulating valve. This valve has a pilot actuated by a float or other primary control, which admits the supply pressure to a hydraulic piston following up and moving with the pilot, thus avoiding over-travel and hunting. Both the main valve and the pilot valve are single seated and close with, and are held tightly to seat by the pressure, thus insuring drop tightness. As the pressure of the liquid which is being controlled is utilized for the operation of the valve, no auxiliary operating fluid is required.

As shown in the accompanying cross-section the valve is in the closed position, with the inlet opening at the left and the outlet at the right. Into the valve body is screwed a combined hydraulic power cylinder and seat ring. The power end of the cylinder is somewhat larger in diameter than is the port opening through the seat, and V-shaped flow ports are cut in the small diameter part of the cylinder connecting the power end with the seat. Working within the cylinder is a combined piston and single seated valve,



the upper or piston part being of large diameter to fit the large diameter of the working cylinder, while the valve part extends down past the flow ports and engages with the seat when in the closed position. When this valve and the pilot valve are in the closed position, as shown, pressure equalization takes place between the inlet and the space above the piston and the valve is held tightly to its seat by the inlet pressure.

The pilot valve, which seats upon a port pierced through the center of the valve disk, is actuated directly by the external lever through a rotary spindle and connecting rod, as shown, and when the pilot valve is lifted the pressure above the valve and piston at once drops to the pressure existing on the outflow side of the valve. The inlet pressure acting upon the annular area enclosed between the circle of the valve seat and the larger circle of the operating cylinder is then unopposed and lifts the main valve. The latter cannot move suddenly, however, as the inflow to the annular space is throttled. The rise of the valve will continue until the pilot port again approaches the pilot valve, whereupon the outflow from the piston and main valve will be restricted, bringing the main valve to rest in such a position that the rate of inflow to the space above the piston and the rate of outflow through the pilot are equal.

When the float moves the pilot valve towards the closed position, pressure at once builds up above the piston and main valve and forces the latter toward the closed position, the action continuing as far as the pilot follow up, until the main valve is again closed. Should there be only a negligible pressure on the supply, the float may operate the main valve directly.

The bodies of the larger valves are ordinarily made of either cast iron or cast steel, depending upon the pressure, while the operating cylinder and valve seat are of brass or bronze. In order to allow for the difference in thermal expansion of the two metals the joint between the cylinder and the valve casing is sealed by means of a split ring, which permits of sufficient clearance being provided between cylinder and casing for thermal expansion and contraction to take place without pinching.

NEW CATALOGS AND BULLETINS

Any of the following publications will be sent to you upon request. Address your request direct to the manufacturer and mention COMBUSTION Magazine

Automatic Coal Scales

Bulletin 8132 entitled Fuel Savers for Small as well as Large Power Plants describes the Richardson Apron Feed Automatic Coal Scale. This scale has an ample hourly capacity for the average small power plant having boilers ranging from about 125 to 500 hp. It has a unit weighing capacity of 50 lb. of any grade of small crushed coal. It is capable of weighing from ½ ton to 3 tons per hour. This bulletin includes many sketches and illustrations and a discussion entitled "Your Coal Pile Needs a Guardian." 12 pages, 8½ x 11—Richardson Scale Company, Clifton, New Jersey.

Automatic Stokers

A catalog has just been issued by the Modern Coal Burner Company, a subsidiary of the Peabody Coal Company, describing the Modern Coal Burner. This burner is of the center retort underfeed stoker type. This catalog describes the many features of this new type of fuel burning device and clearly describes and illustrates the many details. 16 pages, 8½ x 11—Modern Coal Burner Company, 3733 Lincoln Avenue, Chicago.

Boiler Return System

Bulletin 632 describes the Schaub Boiler Return System. This system performs three boiler operations automatically, namely, returns high and low pressure condensation, supplies make-up water to the boiler and maintains uniform water level in the boiler. The system is built in all sizes for boilers ranging up to and over 300 hp. and for all working pressures from 5 to 150 lb. A history of the development of the Schaub Boiler Return System is set forth together with a description of all the elements comprising this system. Tables and illustrations. 4 pages, 8½ x 11—Fred H. Schaub Engineering Company, 325 W. Huron Street, Chicago.

Centrifugal Pumps

Bulletin W-323-B1 describes the Worthington Centrifugal Pumps arranged for automatic priming. It is a well-known fact that the conventional type of centrifugal pump will not prime itself and that an auxiliary priming device is required where the pump is located above the level of its liquid supply. This Worthington pumping unit is equipped with an auxiliary device that accomplishes this priming without the attention of an operator. 4 pages, 8½ x 11—Worthington Pump and Machinery Corporation, 2 Park Avenue, New York.

Elevator Bucket Washers

Rubber pulley lagging increases the coefficient of friction between a rubber belt and a dry pulley face about 20 per cent and is particularly recommended for drive pulleys on belt conveyors and bucket elevators to improve pulley grip and prevent slipping, declares a two page insert for its mechanical goods catalog, just issued by The B. F. Goodrich Rubber Company, Akron, Ohio. Directions for applying are also included.

Gas Engines

A folder describing the Worthington Horizontal Four Cycle, Double Acting Gas Engine has just been issued. This engine is of the single tandem or twin tandem horizontal cylinder type. It is available in capacities of 480 to 1000 hp. This folder is well illustrated and includes tables. 6 pages, 8½ x 11—Worthington Pump and Machinery Corporation, 2 Park Avenue, New York.

Inclined Gage Glass Valves

Two folders have just been issued describing Ernst Adjustable Inclined Gage Glass Valves and Ernst Heavy Duty Adjustable Split Gland Water Gage. These gages are suitable for pressures up to 900 lb. per sq. in. 2 pages each, 8½ x 11—Ernst Water Column & Gage Company, Newark, New Jersey.

Lubricating Equipment

Catalog No. 30 describes the Lincoln Flex-O-Matic Lubricating Equipment for industrial lubrication. This catalog is well illustrated and includes tables of data and detailed sketches. 14 pages, 8½ x 11—Lincoln Engineering Company, 5701 Natural Bridge Avenue, Saint Louis, Mo.

Refractory Cement

A pamphlet has just been issued describing Refractory Cement manufactured and sold by the Johns-Manville Corporation. This pamphlet also describes the various features of Johns-Manville Cement and includes discussions entitled as follows. Need for Refractory Cement, Plastic Demonstration of Fire Brick, Slagging, Spalling, Clinkering, etc. A table of technical data is shown. 16 pages, 3½ x 6—Johns-Manville Corporation, 392 Madison Avenue, New York.

Remote Control Valves

A folder has just been published entitled "Why Thrustor Valves?" The Thrustor Valve is operated by a self-contained power unit—the General Electric Thrustor. This power unit consists of an electric motor controlling an improved hydraulic cylinder that produces a smooth, straight-line, constant-pressure thrust. This combination is claimed to give smooth valve operation, to permit the use of simplified control and trouble-free service throughout the operating life of the valve. The folder includes many illustrations. 6 pages, 7 x 10—General Electric Company, Schenectady, N. Y.

Speed Reducers

Bulletin No. 260 describes the Falk Motoreducers. The Falk Corporation announces in this bulletin a line of speed reducers in which the following features have been retained: ease of maintenance, adaptability to change, freedom from contamination of motor windings by gear lubricant, freedom in choice of motors, and also some distinctly novel features. Any ratio between 4.6 to 1 and 228 to 1 can be obtained in any standard Motoreducer. Extremely high ratios are also obtainable with special units. 12 pages, 8½ x 11—The Falk Corporation, Milwaukee, Wisconsin.

Temperature Controller

A pamphlet has been issued by Lucius Pitkin, Inc., describing the Tour Temperature Controller. This controller was developed by R. S. Tour, Professor of Chemical Engineering at the University of Cincinnati. It is claimed to embody entirely new principles of operation and hence many features which are entirely new to temperature controllers. 4 pages, 8½ x 11—Lucius Pitkin, Inc., 47 Fulton Street, New York.

Welded Fire-Tube Boilers

Bulletin HT-9 recently issued by The Hedges-Walsh-Weidner Company describes and illustrates its new line of H-W-W Welded Fire-Tube Boilers. This type boiler has eliminated the fire cracks and girth seam leaks which have been the principal disadvantages of Horizontal Return Tubular Boilers, and has made possible ratings as high as 200 per cent and pressures higher than those considered practical for riveted h.r.t. boilers. This boiler is built in units ranging from 50 to 400 hp. and is adaptable for any class of fuel. 4 pages, 8½ x 11—The Hedges-Walsh-Weidner Company, Chattanooga, Tennessee.

NOTICE

Manufacturers are requested to send copies of their new catalogs and bulletins for review on this page. Address copies of your new literature to

COMBUSTION
200 Madison Ave., New York

REVIEW OF NEW TECHNICAL BOOKS

Any of the books reviewed on this page may be secured from In-Ce-Co Publishing Corporation, 200 Madison Avenue, New York

Technical Data on Fuel

Edited by H. M. Spiers

Technical Data on Fuel, originally published as one of the British contributions to the Fuel Conference, held in London as a Sectional Meeting of the World Power Conference in 1928, was so enthusiastically received by engineers of all countries that within four years two editions have been exhausted and a third, completely revised, has just been issued. Further data have been added to this new edition, and the contents are now approximately 75 per cent greater than the contents of the first edition. This volume was prepared with the close co-operation of leading British fuel technologists under the editorship of H. M. Spiers of the Research Section of The Woodall-Duckham Companies.

Introducing the third edition of this book, Mr. E. W. Smith, Chairman of the Technical Data on Fuel Sub-Committee, says, "The field covered by fuel technology is so extensive that chemists and engineers must have recourse to a wide range of literature to obtain data covering the varied problems confronting them from day to day. The present volume has been compiled with the object of rendering available in handy form some of the information constantly required in the various branches of the subject. No attempt at completeness has been made, for that would have involved a volume as large as one of the well-known engineer's hand-books. Consequently, the selection of the subject matter has been somewhat arbitrary, some of it being of general application and some of a specialized character. Data such as are readily available have been deliberately omitted, though in some cases it has been felt desirable not to act strictly in accordance with this principle."

The book is divided into 14 main divisions and numerous sub-divisions. The main divisions are as follows: General Information (Atomic Weights, Logarithms, Antilogarithms, etc.); Air, Water and Gases; Specific Heat; Thermodynamic Properties of Materials; Thermal Conductivity and Heat Transfer; Metals and Alloys; Refractories; Fuel—General Introduction; Gaseous Fuels; Liquid Fuels; Solid Fuels; Stack Losses; Miscellaneous Thermal Data; and Bibliography.

A special feature of this book, which met with general approval in the first two editions and which has, therefore, been retained in the present edition, is the provision throughout the volume of a number of blank pages so that the owner may place any additional information he may acquire under its correct heading.

The volume is of a convenient pocket size, 5½ x 7, and has a flexible cloth binding. It contains 302 pages, including a comprehensive index, 210 tables and 57 diagrams. Price $2.75.

A.S.T.M. Tentative Standards—1932

THE Book of A.S.T.M. Tentative Standards is issued annually by the American Society for Testing Materials. Each year this book includes all of the tentative standards in effect at the time of its publication. The term "tentative" is applied to a proposed standard, which is given approval throughout the various steps of A.S.T.M. procedure and which is published for one or more years to elicit comments and criticisms before it is formally adopted and issued as an A.S.T.M. standard.

The 1932 Book of A.S.T.M. Tentative Standards includes all of the 226 tentative specifications, test methods, definitions of terms and recommended practices effective as of October 31, 1932. Of this number 47 were accepted for publication for the first time in 1932. The items covered include ferrous and non-ferrous metals, cement, lime, gypsum, concrete and clay products, preservative coatings, petroleum products and lubricants, road materials, coal, coke timber, timber preservatives, shipping containers, waterproofing and roofing materials, slate and building stone, electrical insulating materials, rubber products, textile materials, and a number of miscellaneous materials. A comprehensive subject index and a complete table of contents are also contained in this volume.

This volume should prove most convenient for reference purposes. The specifications and methods of test, although still in the trial stage of the A.S.T.M. procedure, represent the latest thought of the committees on the subjects covered and therefore are finding important applications in the various industries. Since the tentative standards may frequently be used in conjunction with A.S.T.M. standards, the volume is complementary to the volumes containing the standards, namely, the Book of A.S.T.M. Standards (Part I on Metals and Part II on Non-Metallic Materials) with its supplements.

In addition to the A.S.T.M. tentative standards, this book includes proposed revisions of standards, published with a view of eliciting criticisms, of which the committees concerned will take due cognizance before recommending final action.

This publication, comprising 1236 pages, 6 x 9 overall, is available in both blue cloth and paper covers, the cloth cover being priced at $8.00, and the paper at $7.00.

BOOKS

1—The problem of Fluctuating Loads on Boilers

By G. E. Hider

115 Pages Price $3.00

The subtitle of this book is "An Investigation into the Characteristics of Different Types of Boilers, their Effect on Production Costs, and the Influence of Thermal Storage Systems." The book stresses the importance of water content as a factor in boiler efficiency, a matter frequently overlooked in other books on the subject. It is pointed out that under conditions of rapidly fluctuating loads such as obtain in many industries, the quantity of steam delivered into the main is often far less than that corresponding to the feedwater entering the boiler and that the difference is a function of the water content of the boiler. This book should be of interest to engineers in large and small plants.

2—Boiler Feed Water Purification

By S. T. Powell

363 Pages Price $4.00

A presentation of such basic facts concerning feed water treatment as may assist the designing engineer in the selection of the appropriate type of treatment and may aid the operating engineer in controlling the system most efficiently.

3—Handbook of Oil Burning

By Harry F. Tapp

629 Pages Price $3.00

Contains information of practical value to the engineer or contractor whose work requires a knowledge of oil burning, heating or power equipment. Covers comprehensively the industrial application of oil as fuel, with drawings, illustrations and tables of this style of installation. Also discusses the various types of oil burner and principles of construction, oil burner controls and motors and fuel tanks and storage. Contains also a wealth of general information such as the chemistry of combustion and flame, fundamentals of heat and heat transfer, the determination of heating capacity requirements and comparative fuel costs.

4—World Economic Survey 1931-32

327 Pages $2.50

The first *World Economic Survey*, issued by the League of Nations, gives a comprehensive review of the development of the world depression up to the middle of January, 1932.

The first chapters set forth the elements of instability in the post-war economic situation, movements of population and of industrial production, the increasing rigidity of economic organization, the shifts in international indebtedness and trading relationships resulting from the war. Special stress is laid upon the importance of movements of capital from one country to another and upon the relation of the credit expansion of 1925-29 to such capital movements.

The main body of the Survey consists of an analysis of the developments of the depression in its various aspects:—the disorganization of production, prices and trade; the difficulties that have arisen in the balancing of international accounts; the growth of unemployment; the strain on the public finances of most countries; and the drift of commercial policy towards increasing measures of trade restriction. A final chapter surveys the position that existed in July, 1932, and the various international measures under consideration as a means of escape from the crisis.

5—A Handbook of English in Engineering Use

308 Pages By A. C. Howell Price $2.50

Here is a real up-to-the-minute handbook that should be on the desk of every technical writer. Most engineers today have occasion to do considerable writing, and for those who have some doubt as to their ability to express themselves clearly, accurately and in acceptable form, Professor Howell's book will be of very definite value. The author takes a very practical point with regard to the engineer's professional use of language. Chapters are devoted to word usage and idioms, sentence and paragraph structure, composition, punctuation and the mechanics of writing and grammar. Examples cover letters, reports and technical articles.

6—Kempe's Engineer's Year-Book for 1932

3000 Pages 7 x 5 $7.00

This publication brings together all the technical information which an engineer has to use day by day. It is a library in itself, a veritable encyclopaedia of modern practice in civil, mechanical, electrical, marine, gas, aero, mine and metallurgical engineering. It is of value to the practicing engineer, the consultant, the manufacturer, power user, contractor, works manager, draftsman and technical student. In this new edition, the 39th, up-to-date information and tables have been introduced, old matter re-arranged, and obsolete material omitted.

7—Water Analysis

For Sanitary and Technical Purposes

By Herbert B. Stocks

135 Pages $3.50

Public health officers, city chemists and those engaged in the study of this branch of analytical work will be interested in this new edition of a book which has long been a standard in this country and England on the subject of the methods adopted for the analysis of water for sanitary and technical purposes. It has been completely revised, rearranged and added to by W. Gordon Carey.

Modern developments have necessitated new sections dealing with hydrogen ion concentration, the determination of free chlorine in chlorinated water, and the determination of iodides. A section on simple bacteriological methods is included in this edition, and should prove of service to those who use this book.

8—Science in Action

By Edward R. Weidlein and William A. Hamor

310 Pages Price $3.00

The authors, both connected with the Mellon Institute of Industrial Research, present in clear language a sketch of the value of scientific research in American Industry. This interesting and readable book is planned to give the business man, engineer and scientist a comprehensive picture of the place of science in industry—the means and methods of industrial research, the results achieved, the important factors in procedure and the choice of workers.

9—Pulverized Fuel Firing

By Sydney H. North

204 Pages Illustrated Price $2.25

The author of this book, an Englishman, briefly reviews the history of pulverized fuel as a prelude to a discussion of its development to the present day. Contemporary designs of furnaces, burners, feeders, pulverizing mills, driers, dust collectors, etc., are described and illustrated, as are actual installations in America and Europe which exemplify the trends of practice. Chapters are devoted to the combustion of pulverized fuel and its use in connection with Lancashire boilers, marine boilers and in metallurgical furnaces.

Postage prepaid in the United States on all orders accompanied by remittance or amounting to five dollars or over.

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Waste Heat Boiler for Drying Furnaces in Paper Manufacture

Editorial Note: A correspondent has recently sent us the illustration below, showing an interesting design of waste heat boiler. The following information is given concerning its application.

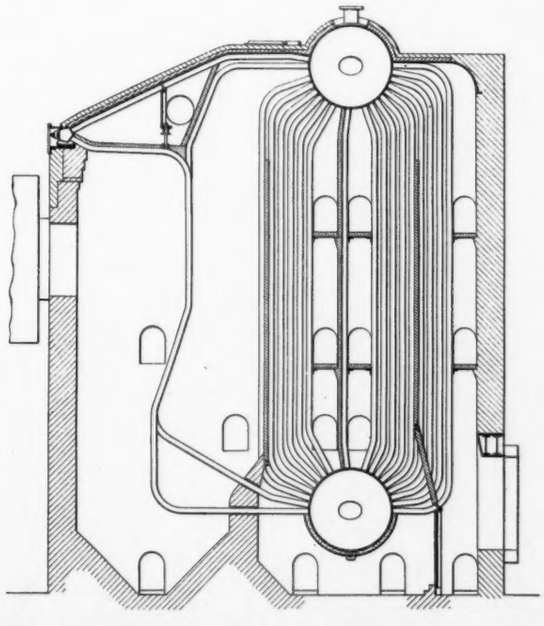
●

In the manufacture of paper, after cooking the chipped wood in a digester containing steam coils, with the liquor, the pulp is blown into a pit and thereafter thoroughly washed in tanks in several washings of waste liquors of successively diluted mixtures and finally with water. The waste liquors go to a recovery system consisting of evaporators and rotary furnaces. Multiple effect and/or disc evaporators concentrate the liquor to such degree that it will support its own combustion in the rotary furnaces, which are similar to rotary driers. The liquor is run in at the end opposite the firebox, gradually runs forward as it burns, and the black ash residue falls out of the cylinder just back of the firebox. The heat produced is run to boilers which supply steam for the evaporators.

The liquor contains organic matter in solution and, depending on the process, carbonate of soda or sulphate of soda. The organic matter burns off leaving carbonate or sulphate of soda, unburned carbon and incombustible mineral matter, a mixture known as black ash.

The fumes given off from the rotary drier are condensable and if not sufficiently cooled before they enter the boiler tube bank will deposit and build up within the tube bank.

In the design illustrated two water-cooled passes, and also a water screen, through which the gases must pass before entering the tube bank of the boiler are provided. The two passes and screen provide an effective cooling and condense out the objectionable matter in the fumes.



Boiler, Stoker and Pulverized Fuel Equipment Sales

As reported by equipment manufacturers to the Department of Commerce, Bureau of the Census.

Boiler Sales

Orders for 371 boilers were placed in October by 72 manufacturers

	Number	Square feet
October, 1932	371	220,567
October, 1931	640	432,800
January to October (inclusive, 1932)	3,068	2,907,736
Equivalent period, 1931	6,654	5,566,485
Total, 1931	7,508	6,327,262

NEW ORDERS, BY KIND, PLACED IN OCTOBER, 1931-1932

Kind	October, 1931 Number	October, 1931 Square feet	October, 1932 Number	October, 1932 Square feet
Stationary:				
Water tube	37	153,171	25	75,277
Horizontal return tubular	40	56,436	20	22,193
Vertical fire tube	57	14,089	33	7,261
Locomotive, not railway	7	6,239	6	4,327
Steel heating	459	168,950	274	104,814
Oil country	....	....	....	....
Self contained portable	35	32,070	8	4,326
Miscellaneous	5	1,845	5	2,369
Total	640	432,800	371	110,567

Mechanical Stoker Sales

Orders for 117 stokers totaling 20,819 hp. were placed in October by 55 manufacturers

	Installed under Fire-tube boilers No.	Fire-tube boilers Horsepower	Water-tube boilers No.	Water-tube boilers Horsepower
October, 1932	96	13,240	21	7,579
October, 1931	231	30,695	54	19,328
January to October (inclusive, 1932)	763	100,467	335	129,394
Equivalent period, 1931	1,602	212,197	516	171,257
Total, 1931	1,889	252,571	574	187,507

Pulverized Fuel Equipment Sales

Orders for 10 pulverizers with a total capacity of 38,500 lb. per hr. were placed in October

	STORAGE SYSTEM: Pulverizers: Total Number	No. for new boilers, furnaces and kilns	No. for existing boilers	Total capacity lb. coal per hour for contract	Water-tube Boilers: Number	Total sq. ft. steam generating surface	Total lb. steam per hour equivalent
October, 1932	..	..	..	....	..	....	.....
October, 1931	1	1	..	30,000	1	11,894	126,000
January to October (inclusive, 1932)	..	..	..	....	..	....	.....
Equivalent period, 1931	8	7	1	250,000	4	126,471	1,797,000
Total, 1931	8	7	1	250,000	4	126,471	1,797,000
DIRECT FIRED OR UNIT SYSTEM: Pulverizers					**Water-tube Boilers**		
October, 1932	10	6	4	38,500	10	50,190	320,100
October, 1931	1	1	..	2,650	1	3,600	24,000
January to October (inclusive, 1932)	65	40	25	300,888	60	311,994	2,629,060
Equivalent period, 1931	65	48	17	430,610	51	386,887	4,269,995
Total, 1931	72	52	20	450,960	58	417,327	4,455,585
					Fire-tube Boilers		
October, 1932	..	..	..	....	..	....	.....
October, 1931	2	..	2	3,500	3	6,000	34,000
January to October (inclusive, 1932)	13	2	11	13,300	13	20,310	114,650
Equivalent period, 1931	34	11	23	38,800	36	58,261	340,100
Total, 1931	35	1	24	39,300	37	59,761	347,100

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